Notes

Atomic Energy Control Board | Commission de contrôle de l'énergie atomique

INFORMATION BULLETIN 87-1 May 26, 1987

REGULATORY RESEARCH PROGRAM FOR 1987/88
PROJECT DESCRIPTIONS

The Regulatory Research Program is intended to augment and extend the Atomic Energy Control Board's regulatory program beyond the capability of in-house resources. The overall objective of the research program is to produce pertinent and independent information that will assist the Board and its staff in making correct, timely and credible decisions on regulating nuclear energy.

The program is divided into ten main areas of research covering the safety of nuclear facilities, radioactive waste management, health physics, physical security and the development of regulatory processes. A total of 67 projects are planned for 1987/88, including a number which are ongoing from the previous fiscal year. Projects that are held in reserve in case funding becomes available are also listed.

Most of the projects will be carried out under contracts issued through Supply and Services Canada.

This Information Bulletin contains a list of the projects with a brief description of each, and additional supporting information.

A separate document describing how the AECB Regulatory Research Program is administered (INFO-0157) may be obtained by contacting:

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- 30 -

E R R A T A

As a result of a necessary last minute change to our project numbering system, some items have an incorrect project number reference.

Page 85, Panel H3
3.101.1 should be 4.101.1

Page 85, Panel H4
5.111.1 should be 3.111.1

Page 86, Panel H5
3.103.2 should be 4.103.2

Page 88, Panel S1
4.101.1 should be 5.104.1

Page 88, Panel S2
5.104.1 should be 3.104.1

Panel S2.1
5.110.4 should be 3.110.4

Panel S2.2
5.101.1 should be 3.101.1

Panel S2.3
5.102.1 should be 3.102.1

Panel S2.4
4.104.1 should be 5.104.1

Page 89, Panel S3
5.105.1 should be 3.105.1
5.109.2 should be 3.109.2
4.112.1 should be 5.112.1

Panel S3.1
5.106.2 should be 3.106.2

Page 89, Panel S4
4.101.1 should be 5.101.1
5.108.1 should be 3.108.1

Also, pages numbered 91 to 104 are attached to replace the similarly-numbered pages at the end of "Regulatory Research Program for 1987/88".

REGULATORY RESEARCH PROGRAM 1987/88

Table of Contents

	Page
Regulatory Research Program 1987/88	1
Summary Analysis of AECB R & D Budget by Mission Object	81
Explanation of Project Summaries	82
List of Review Panels for R & D Projects	84
Cross Reference: 'New' vs 'Old' Project Numbers*	91
Cross Reference: 'Old' vs 'New' Project Numbers*	98
Standard Abbreviations, AECB Organizational Units	104

*New = as of 1987-88 program year.
Old = 1986-87 program year or earlier.

2. Nuclear Reactors

2.101.1 Instrument Behaviour under Off-Normal Conditions (84.1.6)

It is proposed to conduct a study on the behaviour, during and after selected hypothetical severe accident conditions, of instruments used in CANDU reactors. Emphasis would be placed on the accuracy of thermocouples, pressure transducers and flow meters during and after being forced to operate at the extremes of, or outside, their scales.

Information on instrument behaviour during and after severe accident conditions is scarce. This work, therefore, would generate new knowledge necessary to improve the understanding of instrument readings during and after abnormal events.

The results of this study would be used in assessing licensee assumptions and interpolations regarding accident scenarios described by instrument-reading records.

Project Manager: A. Omar
Proponent: SSS, SED
Evaluator: SED (B. Finigan)
Contractor:
Category: 3c Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K			$50K

2.102.1 A Tool to Analyze Real-Time Programs (84.1.20)

A project is proposed to survey the latest developments in computer program analysis and testing, using graph theory as applied to real-time critical systems. Then, based on the results of the survey, it is proposed to acquire or develop a program graphing software tool to analyze the complexity and verification/validation test coverage aspects of safety-related nuclear system software.

Due to the combination of the number of inputs and processing pathways, computer programs used to control nuclear reactor systems are very difficult to verify and validate to an acceptable degree of confidence. Even using extensive test data some design and programming faults may go undetected resulting in the possibility of a critical failure at some future time given a certain set of input and processing conditions.

The results of the survey phase would provide AECB staff with the latest information concerning analysis of critical software, enabling a knowledgeable assessment of the particular methods and test data used by

licensees to verify and validate their nuclear software. The resulting software tool may provide an effective means for AECB staff to rigourously and independently evaluate the testability of a particular system and the extent of test coverage proposed by the licensee.

Project Manager: D.E. Connelly
Proponent: SED, SSS
Evaluator: SED (J. Kendall); SSS (D.E. Connelly)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K			$60K

2.103.1 Aerosols and Fission Product Transport (85.1.4)

A project is proposed to investigate the potential effects of aerosols on fission product transport within and without reactor containment, and to assess mathematical models and computer codes used to describe aerosol behaviour.

Recent advances in the modelling of fission product behaviour in containment are resulting in decreases in the predicted quantities of gas-phase radioisotopes available to contribute to public radiation doses after a postulated accident in a CANDU nuclear power plant. This implies that the relative importance of the airborne liquid-phase and airborne solid-phase components have been increased. The intent of this project would be to perform an initial evaluation of the extent of this potential contribution to doses, and to assess the suitability of available mathematical models for CANDU safety analyses.

The results of this project would be of use to AECB staff both in the formulation of guidelines and requirements for safety analyses and in the assessment of future license applications for CANDU nuclear power plants in which aerosol modelling may be included.

Project Manager: D.E. Connelly
Proponent: SED
Evaluator: SED (R. Ferch)
Contractor:
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$25K			$25K

2.104.1 The Use of Full-Scope Simulators in Training and Qualification (85.1.7)

A project is proposed which would encompass a review of and recommendations for methods by which CANDU nuclear power plant control room operators and shift supervisors could be tested by the utilities during training, and by the AECB for certification purposes using full-scope simulators. This project would also develop an experimental method for evaluating full-scope simulator testing methods.

This project is required to support the activities of the AECB Operator Certification Group and to ensure that control room operators and shift supervisors are suitably tested by the utilities during simulator training and are effectively examined by the AECB on full scope simulators for certification purposes.

The result of this project will be used by the AECB Operator Certification Group to assess the adequacy of the utilities' simulator testing methods for shift supervisors and control room operators and in the continuing development of effective certification examinations.

Project Manager: D.J. Martin
Proponent: OCRFD
Evaluator: OCRFD (F. Davediuk)
Contractor: Human Factors North
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$30K	$60K			$90K

(A)	(B)	(C)
2.105.1	Crack Propagation in Tough Ductile Materials	(85.1.8)

(D)

"WHAT"

It is proposed: a) To perform experimental work which would examine elastic-plastic fracture behaviour in steels which are typical of materials used in CANDU primary heat transport systems; and to explore whether small specimen tests can be used to characterize "lower bound" crack behaviour under the range of elastic-plastic strain conditions encountered in CANDU primary heat transport system components (Phase 1). b) To evaluate the effectiveness of crack displacement and energy based fracture toughness methods of describing crack propagation behaviour under elastic-plastic strain conditions. This should include studies of the individual approaches and an investigation into the viability of a combined energy and crack displacement approach as a route towards a representative model for a wide range of crack growth (Phase 2).

"WHY"

The project arises from the recommendations of a recently completed review of crack and fracture behaviour in tough, ductile materials (84.1.38), which showed a need to incorporate elastic-plastic fracture mechanics considerations into the analysis and design of metallic structural components. The project is aimed at the eventual development of a practical method for the analysis and assessment of stable crack growth under elastic-plastic strain conditions.

(D) (Cont'd) "HOW"	The results of the project would be used as reference information to enable more effective appraisal of safety margins in defect dispositioning and other crack stability assessment work.
(E)	Project Manager: J. Pachner
(F)	Proponent: CQAD
(G)	Evaluator: CQAD (J.K. Pereira)
(H)	Contractor: University of Toronto
(I)	Category: 1* (J) Review Panel: No

(K)	Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$45K	$15K			$60K

(L)	Earlier Directly Related Projects and Funding: $25K	84.1.38 $25K

2.106.1 Selection of Equipment for Equipment Qualification (86.1.1)

It is proposed to identify equipment and components of CANDU NPPs whose impairment could result in significant impact on plant safety and which, therefore, should be qualified for exposure to accident and post-accident environmental conditions. This identification would be based on a review of existing reliability analyses, safety design matrices and expert knowledge of the design and operation of the plant systems.

Comprehensive environmental qualification of NPP equipment will be carried out for the first time in Canada for the Darlington NPP. As a result, AECB staff will have to assess the adequacy of equipment qualification as a part of the Darlington NPP licensing process. In addition, AECB staff wish to review the environmental qualification of safety-related equipment in already operating plants.

This project would identify the significant safety-related equipment and components that should be qualified for the Darlington NPP, and which should be considered for qualification at operating NPPs. Using the results of the work, AECB staff would be able to confirm whether the identified equipment and components were included in the equipment qualification process.

Project Manager: J. Pachner
Proponent: SSS, PRDA&B
Evaluator: PRDA (B.M. Ewing, R. Leblanc); SED (B. Finigan)
Contractor: Monserco Limited
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$10K	$40K			$50K

2.107.1 Technical Basis for Equipment Qualification Assessments (86.1.2)

It is proposed to fund a project which has the following objectives: a) to compile existing Canadian and foreign regulatory requirements and industry standards pertinent to NPP equipment qualification (EQ) and to determine the currency of these requirements in the light of up-to-date research results; b) to prepare an EQ review procedure for use by the AECB in assessing EQ licensing submissions; and c) to recommend evaluation criteria for use in the assessment of CANDU EQ licensing submissions.

Canadian regulatory requirements for the EQ of NPP equipment are expressed in general terms in proposed regulatory guides for the special safety systems. However, no criteria or guidelines that would establish which qualification methods are acceptable are given. Thus, it is important to develop a technical basis for review of EQ licensing submissions.

The project will produce a documented technical basis, a review procedure, and evaluation criteria for use by AECB staff in the assessment of Darlington EQ licensing submissions, and in the assessment of the adequacy of the environmental qualification of selected safety equipment and components in operating NPPs.

Project Manager: J. Pachner
Proponent: SSS, PRDA&B
Evaluator: PRDA (J.P. Marchildon, R. Leblanc); SED (B. Finigan)
Contractor: Monserco Limited
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$28K	$11K			$39K

2.108.1 Survey of NPP Environments for Equipment Qualification (86.1.3)

It is proposed: a) to determine the expected type and range of actual plant environments (in selected plants and plant areas) to which various safety-related equipment and components are normally exposed during their service life; and b) to assess if the currently used accelerated aging methods account for these environments. The contractor would obtain available data on measured plant environments (e.g. radiation, thermal, mechanical stress, gas), and, as necessary, would measure actual environments during plant operation in selected plants and plant areas, and would assess the type and range of the environments and their simulation by the currently used accelerated aging methods.

To assure a conservative basis for equipment qualification testing, equipment should be tested in a state equivalent to the end-of-qualified life condition. Since it is not practical to naturally age equipment to the end-of-life condition, accelerated aging techniques are used to change the equipment to be tested to a state equivalent to end-of-life.

To be able to simulate natural aging, actual plant environments must be known.

The project results would enable AECB staff to assess whether the accelerated aging methods reported in EQ licensing submissions adequately account for normal NPP environments.

Project Manager: J. Pachner
Proponent: SSS, PRDA&B
Evaluator: PRDA (J.P. Marchildon, R. Leblanc)
Contractor:
Category: 3c Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$30K			$30K

2.109.1 Survey of Software Configuration Control Methods (86.1.14)

It is proposed to continue a project which would survey presently available software configuration control methods and assess which of these techniques are applicable, and to what extent, to configuration control of software in nuclear power plants during the development, commissioning and operational phases. This project is a follow-up to an earlier project on computer software quality assurance (84.1.17).

The use of software in nuclear power stations is increasing, mainly due to the introduction of computer control for safety systems. This increases the requirements for systematic configuration control due to the use of similar software in different power plants. Because use of improperly configured software (e.g. use of a wrong version for a certain routine) could adversely impact on safety, the AECB needs to be aware of the relative merits of individual methods, including the most recent developments.

The results of the study would be used as an input in assessing licensees' submissions on configuration control of safety and safety-related software.

Project Manager: D.E. Connelly
Proponent: SSS, SED
Evaluator: SSS (D.E. Connelly); SED (J.D. Kendall)
Contractor: Prior Data Sciences Ltd.
Category: 1* Review Panel: S4

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$10K	$15K			$25K

Earlier Directly Related Projects and Funding: 84.1.17
$6K $14K $20K

2.110.1 Plant Air Quality following Accidental Radioactive Releases (86.1.15)

It is proposed to perform a literature survey and some experiments to determine the feasibility of calculating reliable estimates of nuclear power plant air quality for accidental airborne releases of radioactive material. The contractor would also be asked to recommend appropriate methods for use in deriving such estimates. Specific topics relevant to air quality would include: building wake effects, ventilation and filtering.

In the assessment of air quality following postulated airborne releases of radioactive material, further information is required on effects which could decrease the quality of air under such conditions by, for example, inverting flows in ventilation systems, or by causing localized high concentrations in such areas as the ECC sump.

The results of this project would be used in determining whether reliable estimates can be made of nuclear power plant air quality for accident conditions, specifically in the evaluation of control room habitability and the appropriateness of assembly areas and evacuation routes. If it is decided that such estimates can be made, further work would be proposed.

Project Manager: D.J. Martin
Proponent: SED
Evaluator: SED (L. Truong)
Contractor: Envirodyne
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$22K	$8K			$30K

2.111.1 International Piping Integrity Research Group (86.1.18)

It is proposed to continue membership in the International Piping Integrity Research Group (IPIRG). This group, organized by the U.S. Nuclear Regulatory Commission (USNRC), is examining the fracture behaviour of large piping systems. The proposed program by the USNRC includes: fracture tests done on approximately 60 large-diameter pipes, of which about one third are directly relevant to CANDU; material tests to establish a data base for fracture analysis; assessment of the efficacy of fracture calculations; review of degraded piping; and review of the state-of-the-art analytical and experimental developments. The cost of Canadian participation in the IPIRG program would be shared equally between AECB and Ontario Hydro (each contributing $420K).

There is a need to develop and verify the technology to justify: using analytical assessments to disposition piping defects and prescribe inspection frequencies for them; permitting leak-before-break concepts in lieu of mechanical protection for hypothetical pipe ruptures; and current procedures for response to primary heat transport system leaks.

The results would be used to support, or change, the licensing criteria for protection against pipe rupture, to define in-service inspection frequencies, to develop rules for reactor shutdown after leaks have been detected.

Project Manager: A. Omar
Proponent: CQAD
Evaluator: CQAD (B. Jarman, J.K. Pereira)
Contractor: USNRC/Battelle
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$140K	$140K	$140K	$420K

2.112.1 Microcomputer Software for Heat Transfer Prediction (86.1.19)

It is proposed to continue a study involving the production of a microcomputer-based method suitable for predicting heat transfer conditions encountered during postulated accident scenarios in CANDU reactors. The proposed software package would incorporate up-to-date information in a simple and user-friendly format.

Various correlations describing the heat transfer processes are found in current licensing codes. There are uncertainties relating to the choice of correlations since they depend on several parameters such as geometry and flow regime. To assist in the analysis of such systems there is a need for a simple and inexpensive tool whereby the effect of new correlations on the heat transfer predictions can be examined without running the more complex computer codes.

The resulting software package would be used in the assessment of safety submissions related to postulated accident scenarios such as loss of regulation and loss-of-flow events. In particular, it would be used to check the heat transfer prediction of the more complex computer codes used in licensing calculations.

Project Manager: A. Omar
Proponent: SED
Evaluator: SED (Q.S. Truong)
Contractor: University of Ottawa
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$25K	$7K			$32K

2.113.1 Aging of Elastomers in CANDU Pressure Boundary Service (86.1.20)

It is proposed to fund a project which has the following objectives: a) to compile and evaluate information on aging effects in various elastomeric components in CANDU pressure boundary service and which could result in degradation of the performance of such components over the expected plant life; b) to identify failure modes related to the aging and service wear of the components; c) to identify precursor indicators of the potential failure modes that could be monitored at reasonable cost and plant operator radiation dose to detect approach to failure at an early stage; d) to identify any standards relating to aging that are applicable to CANDU NPPs; and e) to recommend criteria for the evaluation of monitoring and maintenance programs to determine whether these programs adequately account for aging and service wear effects that could have a significant effect on plant safety. The project work would involve a survey, review and evaluation of complex industrial plant (including NPP) operating experience, equipment monitoring and maintenance practices, and a review of the relevant literature.

As the components in nuclear power plants get older, the aging and service wear they experience may have an impact on their ability to perform their intended functions. Only a few industrial standards provide guidance on equipment monitoring and maintenance. These standards are very general in nature and deal only with a limited number of component types. Thus, the availability of a well-founded methodology for the assessment of aging of critical components, equipment and systems, and their impact on plant safety would be of value.

The information generated by this project would be used by AECB staff as an initial technical basis for assessing the impact of aging of the elastomeric components on plant safety and for the possible development of regulatory requirements. Furthermore, the results would allow AECB staff to review and assess the adequacy of NPP monitoring, maintenance and replacement programs related to the detection and mitigation of aging and service wear effects of the specified elastomeric pressure boundary components.

Project Manager: J. Pachner
Proponent: CQAD
Evaluator: CQAD (J.K. Pereira)
Contractor: London Nuclear Ltd.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$35K	$15K			$50K

2.114.2 A Simulator for Evaluating Emergency Operating Procedures (86.1.21)

A research project is proposed which would produce a series of computer modules which simulate the general features of a CANDU 600 MW reactor. The modules would "plug in" to an existing simulation environment (SIMAK).

This project is prompted by a review of Emergency Operating Procedures (EOP) that indicated the need for an analytical tool to assist in understanding the interaction of various plant systems. For example, during a small LOCA from the steam space above the pressurizer at low power, one would expect the pressure to drop quickly and the pressurizer level to drop by about 10% and then rise rapidly. At full power, the pressurizer level should rise as the pressure drops. Such an hypothesis could be tested with this simulation.

The simulation will be used to develop an understanding of the way in which a CANDU 600 MW reactor responds to various accident conditions. This understanding is required to evaluate the suitability of the form and diagnostics in an EOP.

Project Manager: D.J. Martin
Proponent: SED
Evaluator: SED (J.D. Kendall)
Contractor:
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$40K			$40K

Earlier Directly Related Projects and Funding: 86.1.24
$12K $12K

2.115.1 Aging and Malfunction of Valves in CANDU Applications (87.1.1)

It is proposed to fund a project which has the following objectives: a) to assess the effectiveness of current inspection, testing and monitoring methods in terms of their capability to detect aging degradation and other causes of malfunction of selected major valves used in CANDU NPPs before a valve failure occurs; b) to evaluate the effectiveness of current maintenance practices in mitigating aging effects; and c) to recommend guidance for condition monitoring and maintenance methods capable of revealing degradation trends prior to valve failure. This project which would be the first of a series on valves, and would involve a survey, review and evaluation of pertinent CANDU operating experience, condition monitoring, and maintenance practices, and a review of the relevant Canadian and foreign literature.

The proposal originates from an observation that valve malfunction is the most common type of failure encountered in CANDU reactor pressurized

systems. A similar situation is found in U.S. reactor service. Views held there suggest that current surveillance programs may be inadequate and that aging degradation may be an important cause of valve malfunction. Assessment of current condition monitoring schemes/capability and maintenance programs may therefore lead to a reduction in the incidence of valve failures.

Research results would allow AECB staff to review and assess the adequacy of valve condition monitoring, maintenance and replacement programs, and could serve as a basis for the development of regulatory requirements.

Project Manager: J. Pachner
Proponent: CQAD
Evaluator: CQAD (J.K. Pereira)
Contractor:
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K			$50K

2.116.1 Failure Modes of Programmable Controllers and Microprocessors (87.1.2)

It is proposed to initiate a two phase project to study failure modes inherent to programmable controller and industrial microprocessor technology in use, or proposed, for nuclear power station applications. Phase I would involve a rapid survey of the available technology and categorize the products into generic groups. Phase II would assess in detail the failure modes for each of the generic groups and prepare recommendations to the AECB concerning the safety implications such as fault detection and response.

The use of programmable controllers and industrial microprocessors in CANDU nuclear power stations is increasing rapidly both in new stations and in the retrofitting of older units. This technology involves a complex blend of real-time software/firmware and high-performance microcircuit devices for which the reliability history is very limited. AECB staff are required to assess the reliability analyses submitted by licensees for safety and safety-related systems using these components.

The results of this study would assist AECB staff in evaluating licensees' reliability analyses of systems using programmable controllers.

Project Manager: J. Pachner
Proponent: SED
Evaluator: SED (B. Finigan, J.D. Kendall)
Contractor:
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$40K	$30K		$70K

2.117.1 Documentation of Real-Time Power Reactor Software (87.1.3)

It is proposed to survey software documentation standards and practices applicable to real-time systems and identify documentation techniques and elements that would be effective over the entire life cycle of CANDU computer-based process control and safety systems.

Real-time software is being applied extensively both in the newer CANDU power stations and for retrofitting older stations. In addition, existing operational software must undergo many changes throughout its operational phase to correct faults and to adapt to additional requirements. To further complicate the situation, the electrical utilities will likely be left responsible for software system support as their system suppliers and consultants are forced by economic pressures to reduce their activities in this area.

The results of this study would assist AECB staff in assessing the adequacy of documentation for real-time software systems in use and proposed in CANDU nuclear power stations.

Project Manager: D.E. Connelly
Proponent: SED
Evaluator: SED (J.D. Kendall); SSS (D. E. Connelly)
Contractor:
Category: 1 Review Panel: S4

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$30K			$30K

2.118.1 Behaviour of the Calandria Structure under Severe Conditions (87.1.4)

It is proposed to conduct an analytical study to investigate the survivability of the calandria structure under a hypothetical rapid increase in the temperature and pressure of the moderator.

It is uncertain how the calandria structure would eventually fail when subjected to a rapid increase in the temperature and pressure of the moderator. If the upper portion of the calandria (i.e. the reactivity mechanism deck) were to fail first, this would result, on certain CANDU

designs, in a breach of containment. Information is needed, therefore, to determine the consequences of such a hypothetical situation, and then, if necessary, the measures which would be considered to prevent it or mitigate its consequences.

The results of this project would expand the knowledge-base of AECB staff and augment their understanding of the behaviour of a CANDU reactor under a combination of hypothetical human errors and systems response.

Project Manager: A. Omar
Proponent: SED, PRD
Evaluator: CQAD (B. Harman)
Contractor:
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K	$30K		$90K

2.119.2 Updating of the DARSIM Simulation Program (87.1.5)

A project is proposed which would update the DARSIM simulation program to incorporate the expected changes to the Darlington reactor digital shutdown system.

While constructing the Darlington reactor simulation program DARSIM for the AECB, the contractor (Serdula Systems) discovered several important discrepancies between the specification document for the shutdown system and the implementation description document. This means that, as the system stands at present, the trip coverage would not be complete. Some amendments to the specifications of the shutdown system have been made. However, when the licensee completes the changes required to the system, DARSIM will have to be updated to reflect these changes.

The updated DARSIM program would be used in the continuing review of the safety of the proposed Darlington reactor.

Project Manager: D.J. Martin
Proponent: SED
Evaluator: SED (C.T. Downie)
Contractor:
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$25K			$25K

Earlier Directly Related Projects and Funding: 85.1.10
$29K $29K

2.119.3 Conversion of DARSIM to Run on an Apollo Computer (87.1.10)

A project is proposed which would convert the simulation program DARSIM to run on Safety Evaluation Division's Apollo computer.

The project is proposed because the new Apollo is faster than the IBM PC on which the program is currently installed. The conversion to the Apollo would make the simulation package more effective, by allowing it to be run interactively at a speed closer to real time.

The converted program would be used in the continuing safety evaluation of the proposed Darlington reactor.

Project Manager: D.J. Martin
Proponent: SED
Evaluator: SED (C.T. Downie)
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$15K			$15K

Earlier Directly Related Projects and Funding: 85.1.10
$29K $29K

2.120.1 Models for Molten Fuel/Moderator Interaction (87.1.6)

It is proposed to conduct an analytical study to estimate the thermalhydraulic loadings due to steam explosion using different sets of assumptions reflecting various degrees of conservatism. The study would include: a) an upper bound analysis of transient pressure fields resulting from a steam explosion; and b) an investigation to determine the most influencial parameters that might lead to a steam explosion. This would be a follow-up to a previous study (84.1.30) in which existing models were critiqued and the potential for steam explosion in a CANDU system assessed.

The predicted severity and consequences of the interaction between molten fuel and moderator depend on the model adopted. Models are normally based on numerous assumed factors. By carrying out a comparison between models, and then conducting an upper bound analysis, it is anticipated that the consequences of a hypothetical blocked fuel channel event can be addressed.

The results of this project would be used by AECB staff in evaluating the models used for, and the consequences of, a hypothetical case in which a pressure tube/calandria tube rupture takes place with molten fuel interacting with the moderator.

Project Manager: A. Omar
Proponent: SED
Evaluator: SED (V.Q. Tang, Q.S. Truong); CQAD (B. Jarman)
Contractor: Swacer Inc.
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K	$40K		$90K

Earlier Directly Related Projects and Funding: 84.1.30

$32K	$17K		$49K

2.121.1 Study of the Dissemination of Fission Products around Undamaged Spent Fuel Bundles (87.1.7)

It is proposed to study the chemical and physical characteristics of fission products that contaminate surfaces during refuelling operations.

After refuelling operations, it is found that many of the surfaces in the vicinity of spent fuel bundles are contaminated with fission products. It seems that such a contamination problem is common to all nuclear generating stations and occurs whether or not the fuel bundles are damaged. In order to assess the radiotoxicity presented by the contamination, it is necessary to determine the chemical form of the fission products, which will indicate to which solubility class they belong. The determination of their physical characteristics (gas, liquid or solid phase, or the size of the particles to which they attach) will provide information on their transportability from contaminated surfaces to man.

It is anticipated that the results of the study will provide the AECB with an understanding of the possible radiological hazards presented by fission product contamination. Characterizing the chemical and physical properties of the contaminating fission products should provide guidance to remedial measures.

Project Manager: E. Rabin
Proponent: HRS
Evaluator: RPD
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$80K	$70K		$150K

2.122.1 Non-Uniformity of Hydrogen in Fuelling Machine Vaults (87.1.8)

It is proposed to determine the extent of the non-uniformity of hydrogen concentration in a fuelling machine vault following a LOCA and LOCA with LOECC. The work would involve flow visualization and measurement of spatial distribution of hydrogen concentration as a function of time in a 1:10 to 1:20 scale model of the Pickering fuelling machine vault used as a typical case. The location of the hydrogen source, the rate of hydrogen discharge and the hydrogen/steam ratio are the parameters which would be studied.

Current research on hydrogen burn in the fuelling machine vault is aimed at developing a technical basis for predicting the consequences of the burn in terms of pressure and temperature rise in the vault. Important characteristics such as flammability limits, flame propagation and transition to detonation are being investigated, however, burning in non-uniform mixtures has not been addressed. Since hydrogen burning and hence its consequences could be strongly dependent on the hydrogen concentration non-uniformities, it is necessary to determine whether significant non-uniformities could exist in the fuelling machine vault following a LOCA and LOCA with LOECC despite the mixing of gases by the vault cooling fans.

Results of this research would determine whether hydrogen burning in non-uniform mixtures should be investigated in order to predict realistic consequences of hydrogen burn in the fuelling machine vault.

Project Manager: J. Pachner
Proponent: SED
Evaluator: SED (J. Khosla, S. Goindi)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K			$50K

2.123.1 Effect of Geometry on Hydrogen Burn in Calandria (87.1.9)

It is proposed to investigate the burning characteristics of hydrogen in the calandria under conditions of low moderator level. The work would involve measurements of hydrogen burning rate and flame velocities in the axial and lateral directions using representative mixtures of hydrogen, helium, steam and oxygen in a full to 1:10 scale model of the upper segment of the calandria vessel which would include both the calandria and reactivity mechanism tubes.

Current hydrogen combustion research includes studies related to hydrogen burn in the calandria which could occur following postulated events involving drop of moderator level below the top row of calandria tubes. Deuterium evolution, flammability and detonation limits, ignition and other characteristics are being investigated, however,

hydrogen burning in actual calandria geometry is not being addressed and this is a factor which is likely to significantly influence hydrogen burning rate and propagation, and consequently the event consequences.

The results of the research would enable the AECB staff to assess whether the consequences of hydrogen burn predicted on the basis of tests in simple geometries are representative of those likely to occur in the calandria.

Project Manager: J. Pachner
Proponent: SED
Evaluator: SED (J. Khosla, S. Goindi)
Contractor:
Category: 3c Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K			$50K

2.124.1 Cost-Effectiveness of Reduction of Off-Site Dose (85.8.11)

It is proposed to perform a cost-effectiveness analysis to examine alternate nuclear power plant effluent control technologies, their costs, and benefits in terms of reduced off-site dose.

This project is proposed because the AECB has been using a target of one percent of licensed emission limits for liquid and gaseous effluents for several years without verifying, through cost-effectiveness analysis, whether further measures to reduce radiation doses to persons off-site might be reasonably achievable.

It is anticipated that the information obtained from this study will help the Board decide whether additional measures to reduce off-site radiation doses should be required, and whether the current design and operating target (1%) is still appropriate in light of any technological advances that have occurred since this target was established.

Project Manager: D.J. Martin
Proponent: RPD, RRB
Evaluator: RRB (J.W. Beare); RPD (R.M. Chatterjee)
Contractor: Atlantic Nuclear Services Ltd.
Category: 1* Review Panel: S5

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$38K	$11K			$49K

2.125.1 Measurement of Carbon-14 in Food and in the Excretions of Canadians (87.8.4)

It is proposed to measure the amount of carbon and the specific activity of radioactive carbon (C-14) in the daily intake of food and in the daily excretions of urine and stool obtained from healthy Canadians.

At present, the daily excretion rate of C-14 due to occupational exposure to radioactive carbon dioxide and to particulates containing C-14 is calculated by measuring the specific activity (C-14 per gram of stable carbon) in an aliquot of urine or stool, and by adjusting for the total stable carbon output in a 24-hour excretory sample. The amount of stable carbon excreted in a daily sample cannot usually be measured, and it is assumed to be equal to that given for Reference Man in ICRP 23. Additionally, an accurate dose estimation due to an uptake of C-14 requires a knowledge of the relative fraction of ingested C-14, which is eventually excreted in both urine and stool samples. There appears to be significant uncertainty in the values for Reference Man given in ICRP 23. It is therefore important to measure these parameters for Canadians to enable an accurate dose estimation for exposure to C-14 in occupational situations.

The results of this study will improve dose estimates for exposure to C-14 among workers at nuclear facilities and among radioisotope users where C-14 is present.

Project Manager: V. Elaguppillai
Proponent: RPD
Evaluator: RPD (F. Horvath)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K	$20K		$70K

3. Other Fuel Cycle Facilities, General

3.101.1 Demonstration of the Feasibility of Directly Dating Quartz (84.4.1)

Using samples of quartz from rocks of known age it is proposed to examine the feasibility of directly dating the quartz using a technique involving electron spin resonance.

This study is proposed because, in selecting the site for any nuclear facility, it is important to know whether or not the earth's crust in the vicinity of the proposed site is relatively stable. The presence of earthquakes is an obvious indicator of instability. However, some seismically active areas have been known to be quiescent for as long as 2000 years before major seismic activity was renewed yet, in Canada, earthquake records go back a maximum of only 450 years. To help obtain a more accurate estimate of the tectonic conditions, the minimum age of the youngest fault movement should be known.

If the results of using electron-spin resonance to date quartz are positive then the intention would be to indicate to licensees, in the form of guidelines, that, where appropriate, fault-filling quartz be dated.

Project Manager: J.L. Wallach
Proponent: SSS
Evaluator: SSS (J.L. Wallach); WMD (P.A. Flavelle)
Contractor: Dr. A.L. Odom
Category: 1* Review Panel: S2

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$38K	$12K			$50K

3.102.1 Geological Evidence of Seismicity - Charlevoix (85.4.10)

It is proposed that field investigations be undertaken in the Charlevoix, Quebec, earthquake area to look for, document, and evaluate the kinds of land forms, structures in unconsolidated sediments, and changes in sedimentary layers which have been identified elsewhere and have been interpreted as being generically associated with earthquakes.

This study is proposed because the Charlevoix area has been the site of some of eastern Canada's largest earthquakes, yet no studies have been conducted there to look for geological evidence of these events. Therefore, this study, if successful, will provide geological information to supplement the existing seismic data and enable evaluating the nature and periodicity of both historic and pre-historic earthquakes. Because of the coexistence of geologic and seismic data, it would also provide information for estimating seismic risk in areas being considered for nuclear facilities. The study which would cost a total of $175K over the next three years would be carried out in conjunction with the Geological Survey of Canada and the Earth Physics Branch.

The results of this study are intended to be used both in the formulation of guidelines and for evaluating information from licensees regarding estimates of seismic risk to nuclear facilities.

Project Manager: J.L. Wallach
Proponent: SSS
Evaluator: SSS (J.L. Wallach); DRR (Z. Domaratzki)
Contractor: Laval University
Category: 1* Review Panel: S2

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
$17K	$27K	$34K	$18K		$96K

3.103.1 Measurement of Absorbed Fraction of Ingested Uranium in Humans (85.8.12)

It is proposed to determine the absorbed fraction (f_1) of ingested dietary uranium in humans, including those living in uranium mining communities, by measuring the content of uranium in their diet and in their fecal and urinary excretions.

The currently used annual limit on intake (ALI) for uranium, by ingestion, is derived using a value of 0.05 for the absorbed fraction (f_1) of ingested uranium. This fraction is known to have a number of uncertainties, and more work should be done to improve its accuracy.

The results of the study are expected to improve the value for f_1 and hence the estimate of the ALI for uranium.

Project Manager: K.P. Ho
Proponent: RPD
Evaluator: RPD (C. Pomroy)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K	$20K		$80K

3.104.1 Neotectonic Conditions in Eastern Canada - Phase I (86.4.2)

It is proposed to participate in, and contribute to, a Federal-Provincial Working Group, the formation of which is to address geologic conditions and, ultimately, the issue of seismic risk in eastern Canada. The group, known as MAGNEC (Multi-Agency Group for Neotectonics in Eastern Canada), will comprise the Geological Survey of Canada (the coordinating agency), the Ontario Geological Survey, Ontario Hydro, the Ontario Centre for Remote Sensing, and the AECB. Perhaps, Hydro Quebec, the New Brunswick Department of Natural Resources and Energy and the Nova Scotia Department of Mines and Energy will also join. Except for the AECB, and possibly Ontario Hydro, all participating agencies are expected to contribute staff effort, rather than money, to the program.

This program, and AECB participation in it, are proposed because, to date, the assessment of seismic risk has relied solely upon documenting and evaluating historical and current seismic data. This approach has limited value because it is based on the assumption that future earthquakes will occur in areas of past events. Therefore, if a nuclear facility is planned for an area in which earthquakes have not been documented, it is conceivable that the probability of occurrence of a major, disastrous earthquake will be underestimated. Consequently, the design of a nuclear facility to withstand such an earthquake may be inadequate.

It is anticipated that the results of this entire program will provide the AECB with appropriate information for establishing a regulatory position addressing all aspects of seismic risk. The results are also anticipated to be useful in assessing the thoroughness of work undertaken, as well as claims made, by licensees in this particular study area.

Project Manager: J.L. Wallach
Proponent: SSS
Evaluator: SSS (J.L. Wallach); DRR (Z. Domaratzki)
Contractor: EMR (Contractors to be selected under MAGNEC)
Category: 1 Review Panel: S2

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K	$75K	$150K	$275K

3.105.1 Transfer Parameters - Non-Domesticated Animals (86.4.5)

It is proposed to determine the radionuclide content of the tissues of non-domesticated animals hunted and trapped in the Serpent River Drainage Basin. Non-domesticated animals shown to be part of the diet of people living in the Serpent River Basin by a recent survey will be selected for this study.

Currently, transfer parameters are not available for these food-animal pathways. When transfer parameters are required, values obtained for domestic animals are sometimes used. There is little information on the significance of the transfer parameters for these pathways in dose calculations.

Transfer parameters and information gained from this project would be used in evaluating the validity and reliability of derived release limit calculations or any other pathways analysis used in calculating dose to humans.

Project Manager: R. Avadhanula
Proponent: RPD, WMD
Evaluator: RPD (C. Letourneau); WMD (W. Napier)
Contractor: Laurentian University
Category: 1* Review Panel: S3

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$15K	$25K			$40K

3.106.2 Transfer of Radionuclides to Human Milk - Phase 2 Feasibility (86.4.9)

It is proposed to identify and test techniques for determining the concentrations of isotopes of uranium, thorium, radium and lead in human milk and to establish procedures for taking, preparing and storing the samples prior to analysis. In addition it is proposed to obtain a detailed plan for carrying out a field study using the chosen techniques.

This study is proposed because data on the role of human milk in radionuclide transfer are virtually non-existent as shown by the results of a previous project (84.4.17, INFO 0192). In order to obtain these data appropriate analytical and sampling procedures need to be established.

The results of this study would be used to determine the feasibility of conducting a full-scale sampling and analytical program to determine the concentration of selected radionuclides in human milk and the role of human milk in radionuclide transfer.

Project Manager: R. Avadhanula
Proponent: RPD
Evaluator: RPD (C. Letourneau)
Contractor:
Category: 1* Review Panel: S3

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$40K			$40K

Earlier Directly Related Projects and Funding: 84.4.17
$30K $30K

3.106.3 Transfer of Radionuclides to Human Milk - Phase 3 Field Study (87.4.7)

It is proposed to conduct a full-scale sampling and analytical program to determine the concentration factors for radium, lead, thorium and uranium in the pathway from food to human milk.

A literature survey conducted for the AECB (84.4.17, INFO 0192) has shown that little information exists on the transfer of radionuclides via the human milk pathway. As part of an ongoing review, the AECB has decided to conduct research to determine whether this is a significant pathway.

It is anticipated that the results of the study will enable the AECB to determine the importance of human milk in radionuclide transfer and, consequently, to decide whether this pathway should be included in the derivation of release limits for nuclear facilities, such as uranium mines and mills.

Project Manager: R. Avadhanula
Proponent: RPD
Evaluator: RPD (C. Letourneau)
Contractor:
Category: 3b Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K	$60K		$120K

Earlier Directly Related Projects and Funding: 84.4.17, 86.4.9
$30K $40K $70K

3.107.1 Stresses to Induce Failure across Faults and Fractures (87.4.1)

It is proposed to inject fluids into existing faults and fractures, in the Roblindale Quarry, to determine the stress differential required to induce movement along the faults and fractures and, possibly, seismic activity.

This study is proposed to determine whether or not the ambient stress conditions in the quarry as measured in related projects by Ontario Hydro under contract to the AECB (84.4.9, 85.4.14, 86.4.1) are such that slippage along the fractures and faults is likely to occur there in the relatively near future. Such a determination would provide an indication of tectonic stability in that quarry and in the region, as well as a general indication of tectonic stability in eastern Canada.

It is anticipated that the results of this study will be used, in conjunction with the results of other studies, to acquire sufficient relevant information about tectonic and seismic conditions in eastern Canada. These results would then be used, in turn, to evaluate claims made by licensees regarding tectonic stability at relevant sites.

Project Manager: J.L. Wallach
Proponent: SSS
Evaluator: DRR (Z. Domaratzki); SSS (J.L. Wallach)
Contractor: Fracflow Consultants Ltd.
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$40K	$50K		$90K

3.108.1 A Review of the Validation of Environmental Models (87.4.2)

A project is proposed which would review critically the validation of environmental models which calculate dose to members of the public. The project would analyze the validation studies performed for such models throughout the world and discuss the distribution of errors between the values of predicted and observed quantities.

In certain instances, AECB licensees are asked to perform validation studies for models that are used in their license submissions to calculate Derived Release Limits. AECB staff members must assess the acceptability of the model, its validation procedure and the potential difference between predicted and observed quantities. A review of the existing distribution of differences between predicted and observed quantities for environmental models would be of use in the assessment process.

The results of the project would be used in AECB staff assessments of licensee submissions relating to environmental modelling.

Project Manager: D.E. Connelly
Proponent: RPD
Evaluator: RPD (R.M. Chatterjee); WMD (R. Maloney)
Contractor:
Category: 1 Review Panel: S4

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$40K			$40K

3.109.2 Effect of Soil Type on Radionuclides in Plants: Field Study (87.4.4)

It is proposed to measure the radionuclide content of selected plant species growing in various types of soil.

A literature survey (86.4.6) is currently being carried out for the AECB to determine the extent of information available on the effect of soil type on radionuclide uptake by plants. The need for the full study would be determined after the results of the literature survey have been fully reviewed.

The results of this work would assist AECB staff in the assessment of default values for radionuclide uptake used in dose calculations such as the derivation of release limits and dose assessments.

Project Manager: R. Avadhanula
Proponent: RPD
Evaluator: RPD (C. Letourneau)
Contractor: AECL
Category: 2 Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$35K			$35K

Earlier Directly Related Projects and Funding: 86.4.6
$12K $12K

3.110.4 Stress Measurements in Eastern Ontario - Phase 4 (87.4.5)

It is proposed to conclude the stress measurement program in the Roblindale Quarry by measuring, among other things, stresses in the vicinity of subsurface faults and fractures. It is also intended to conduct a series of radar traverses across the floor of the quarry in order to try to determine the configuration of the underlying Precambrian basement. The latter activity is to be undertaken to see if the Precambrian basement has been involved in the rather broad, open folding affecting the entire thickness of the exposed, Upper Middle Ordovician-aged Gull River Formation.

This study, which would continue to be carried out with Ontario Hydro, is proposed in order to gather additional information relevant to assessing seismic risk in eastern Canada. The information from this, and other related studies, such as that being undertaken in the Charlevoix seismic zone, are needed in order to acquire a reliable data base (other than seismic data themselves) and a far more complete understanding of conditions and characteristics which may lead to, and result from, earthquake activity.

It is anticipated that the results of this, and related studies, will eventually be used both for establishing guidelines, and evaluating claims made by licensees, germane to seismic risk.

Project Manager: J.L. Wallach
Proponent: SSS
Evaluator: SSS (J.L. Wallach); DRR (Z. Domaratzki)
Contractor: Ontario Hydro
Category: 1 Review Panel: S2

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$35K			$35K

Earlier Directly Related Projects and Funding: 84.4.9, 85 4.14, 86.4.1
$55K $35K $90K

3.111.1 Compilation and Critical Evaluation of Data Used to Derive Current Dosimetric Models for Uranium (87.8.1)

It is proposed to compile currently known data regarding the intake, transfer (among organs), retention, and excretion rates of uranium in uranium workers, to test currently available metabolic and dosimetric models with different data sets, to compare computed excretion patterns to the observed ones, and to determine which model describes best the known data or how a selected model should be modified to fit the observed data.

Several metabolic models for uranium metabolism exist at present, but none seems to describe realistically uranium transfer, retention, and excretion rates in humans. Since individual doses from occupational uranium intake are generally determined from the interpretation of bioassay data (urinalysis), it is critical that the AECB Radiation Protection Division identify and acquire a reliable tool for dose calculation in the case of exposure to uranium compounds.

It is anticipated that the study will assist in identifying and in providing the AECB staff with the state-of-the-art metabolic and dosimetric model for uranium intake.

Project Manager: P.J. Duport
Proponent: RPD
Evaluator: RPD (F. Horvath)
Contractor:
Category: 1 Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$40K	$30K		$70K

3.112.1 Study of Kidney Functions in Uranium Workers (87.8.2)

It is proposed to study the kidney functions of workers exposed to uranium, and of a control population. The study would be conducted in two phases: Phase I - literature review, feasibility study, recruitment survey, implication of positive results; and Phase II - full-scale study.

Uranium compounds inhaled or ingested in the workplace have various solubility and inter-organ transfer rates in the human body. The chemical toxicity of inhaled or ingested soluble uranium, especially its nephrotoxicity, surpasses its radiotoxicity. Therefore, occupational exposure to soluble uranium will primarily affect kidney tissues and kidney function. However, human kidneys have a functional overcapacity of a factor of six, and kidney functions may be significantly altered before any clinical evidence of tissue damage is perceived. Also, intakes of soluble uranium are rapidly eliminated, and standard albumin tests for kidney damage are considered to be insufficiently sensitive. It has been suggested that kidney damage resulting from uranium intake may last a longer time without clinical evidence of damage, and may be detectable a long time after the intake by more sensitive tests that are currently available.

It is anticipated that the results will indicate whether any sub-clinical deterioration of kidney function occurs in workers occupationally exposed to uranium, and will indicate the feasibility of complementing routine uranium analysis in urine with the systematic search for bioindicators of kidney damage before clinically evident dysfunction occurs.

Project Manager: P.J. Duport
Proponent: RPD
Evaluator: RPD (C. Pomroy)
Contractor:
Category: 3b Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$90K	$40K		$130K

3.113.1 Calculation of Derived Release Limits on a Personal Computer (87.8.3)

It is proposed to convert the existing mainframe computer version of a program for calculating Derived Release Limits (DRL) as per CSA Standard CAN/CSA-N288.1-M, to compile and execute on a personal computer.

The program is currently being run by licensees and their consultants on mainframe computing facilities to prepare DRL submissions to the AECB. AECB staff are required to review these DRLs and are currently performing sample calculations by hand, an ineffective process given the quantity of data involved. Radiation Protection Division staff have ready access to a microprocessor system equipped with a numeric co-processor and adequate storage capacity.

This project would provide AECB staff with a readily-available tool with which to independently review licensees' DRL submissions with considerable improvements in the amount of time required and in effectiveness.

Project Manager: D.E. Connelly
Proponent: RPD
Evaluator: RPD (R.M. Chatterjee, C. Letourneau)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$15K			$15K

3.114.1 Clinical Emergency Response to Accidents Involving Radiation Contamination to Individuals (87.8.7)

It is proposed to fund a study to identify the requirements for suitable emergency response to serious accidents that may involve both significant contamination with radioactive materials and significant non-radiological trauma of an individual worker or groups of workers.

This study is proposed because, when serious accidents involving the contamination with radioactive materials of workers occur, priority must be given to treatment of the exposed individuals in a manner that best ensures their survival and future health, and minimizes the spread of the contamination to others. Suitable emergency response involves specialized equipment and procedures for handling and transport of the accident victims, provisions for both immediate and long-term hospital care, and measures required to return the victims to normal life. This study will identify the requirements for the care, treatment and rehabilitation of accident victims and investigate what is currently available in the vicinity of large nuclear facilities (or where large quantities of radioactive isotopes are used) and in the larger treatment centres in Canada, such as Toronto, Montreal, and other cities.

It is anticipated that the findings of this study will provide guidance to the AECB and to health authorities for setting up emergency response facilities in cases of significant radioactive contamination and injury. The existence of these facilities is likely to enhance significantly the medical emergency aspect of radiation protection in Canada.

Project Manager: E. Rabin
Proponent: RPD, HRS
Evaluator: RPD
Contractor:
Category: 3c Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$20K			$20K

3.115.1 Suitability of Neutron Dosimeters and Survey Meters in Various Field Conditions - Phase I (87.8.8)

It is proposed to fund a project to determine which type(s) of neutron dosimeters for personal dose assessments and survey meters for radiation exposure control is (are) "best suited" for use at certain nuclear facilities (particle accelerators, research reactors, nuclear reactors) and in some applications involving radioisotopes where measurable neutron doses can be received by workers. "Best suited" refers to best energy response (flatness of energy response curve) over the energy range of the neutrons responsible for (most of) the dose received and least affected by the environmental conditions (e.g. temperature, humidity, rf fields present, etc.) at the work sites. In addition, ease of calibration, accuracy and reliability will be addressed in this work. Phase I of this study will be performed as follows. By means of discussions with AECB project officers and staff at identified facilities, and from a thorough search of the open literature, the research team will obtain spectral information on the neutron fields at occupied areas in the work place. The characteristics of neutron dosimeters and survey meters will be obtained from the manufacturers of the instruments and from the open literature. Phase II of the project (Project No. 87.8.16) will, by means of laboratory and field testing, complement the work of Phase I, by providing information not obtainable in the first phase.

This project is proposed because neutron fields at AECB licensed facilities may result in significant exposures to workers. On several occasions, it was found that the type of dosimeter or survey meter used at a nuclear facility or in applications involving radioisotopes was inappropriate for measuring exposure from the particular spectrum of neutron energies present. The findings of this study will provide guidance to AECB staff and licensee personnel with respect to ensuring that appropriate neutron monitoring devices are used.

It is anticipated that the findings of this study will be instrumental in the preparation of a regulatory guide for use by AECB staff and licensees when selecting appropriate instrumentation for radiation protection. As a consequence, an improvement in the accuracy of neutron dosimetry in Canada is likely to be realized.

Project Manager: E. Rabin
Proponent: RPD
Evaluator: RPD (G.S. Poirier)
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$15K			$15K

3.115.2 Suitability of Neutron Dosimeters and Survey Meters in Various Field Conditions - Phase II (87.8.14)

It is proposed to fund a project that, by means of laboratory and field tests, will provide information on the neutron spectra at occupied areas in AECB licensed facilities and on neutron dosimeter/survey meter suitability, where such information does not exist. In addition side-by-side testing of the most suitable neutron detectors for each type of facility and use listed in Phase I (Project No. 87.8.10) will be carried out either at the facilities/workplaces or in the laboratory under conditions of exposure that simulate working conditions at the facilities/workplaces.

This project is proposed to augment the information obtained in Phase I. Performance of this project is therefore conditional upon the findings of Phase I.

It is anticipated that the results arising from an examination of the neutron spectra together with the evaluation of neutron dosimeters and survey meters will result in an optimized use of such equipment.

Project Manager: E. Rabin
Proponent: RPD
Evaluator: RPD (G.S. Poirier)
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$30K	$20K		$50K

3.116.1 Radiation Sensitivity of Organisms Other than Man: A Review (87.8.16)

It is proposed to review and evaluate the scientific literature upon which rests the assumption that humans are the most radiation sensitive organisms in the environment.

In recent years the validity of the assumption that humans are more radiation-sensitive than any other organism in the biosphere has been questioned by groups both national and international. It is important that this assumption, central to the principles of radiation protection of the environment, be valid.

The results of this project will be used to ensure that the environmental radiation protection principles are based on rational and systematically-developed assumptions and measurements.

Project Manager: R. Avadhanula
Proponent: RPD
Evaluator: RPD (R.M. Chatterjee)
Contractor:
Category: 3a Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$25K			$25K

4. Uranium Mines and Mills

4.101.1 Study of the Health Effects of Inhaled Uranium Ore Dust (84.8.11)

It is proposed to provide funding for the ongoing project to study the health effects (cancer mortality and histological defects) on experimental animals exposed to different concentrations of long-lived radioactive dust, such as those encountered in the uranium mines in Ontario and Saskatchewan.

The study is proposed because Canadian uranium miners are occupationally exposed to long-lived dust (containing uranium, thorium and their long-lived daughters), and the contribution of this exposure to the incidence of cancer is not fully understood.

The results of this study will be used to interpret the health effects of long-lived dust on uranium miners and to develop regulatory guidelines for controlling exposures to long-lived radioactive dust.

Project Manager: P.J. Duport
Proponent: HRS, RPD
Evaluator: RPD (F. Horvath)
Contractor: MacLaren Plansearch Inc.
Category: 1* Review Panel: H3

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
$68K	$135K	$255K	$148K	$328K	$934K

4.102.1 Comparison of the Techniques Used in Estimating Past Exposures to Radon Daughters in Canadian Mines (85.8.8)

It is proposed to continue funding the comparison of the techniques used to evaluate past exposures to radon daughters in various Canadian uranium and non-uranium mines.

At present it is not known whether the techniques and assumptions used to estimate past exposures to radon daughters in various Canadian mines, such as those in Newfoundland, Ontario and Saskatchewan, are similar to one another or different. As a result it is difficult to compare the risk estimates obtained from one study to another.

The results of the study should enable the AECB to compare and improve the risk estimates obtained from the various Canadian epidemiological studies.

Project Manager: P.J. Duport
Proponent: ACRP, HRS, UMD
Evaluator: ACRP; ROD (R. Avadhanula)
Contractor: Senes Consultants Ltd.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$12K	$45K	$3K		$60K

4.103.2 Physical Characteristics and Solubility of Long-Lived Airborne Particulates in Uranium Producing and Manufacturing Facilities (85.3.6)

It is proposed to determine experimentally the size distribution, the activity distribution and the solubility of airborne uranium-bearing aerosols in all Canadian uranium mines and mills, refineries, conversion facilities and fuel fabrication plants.

This work is proposed to quantify the hazard presented by airborne radioactive long-lived materials in the concerned facilities. The parameters (size distribution, activity distribution, radionuclide composition and dissolution rate in simulated lung fluid) which are necessary to calculate the committed effective dose equivalent from exposure data must be determined in order to evaluate quantitatively this specific radiation hazard.

It is anticipated that this study will indicate the magnitude of the risk of long-lived particulates in uranium producing and manufacturing industries. It will also provide supporting information for any forthcoming regulation on long-lived dust and will facilitate interpretation of bioassay data for the purpose of the radiation protection of the workers at these facilities.

Project Manager: K.P. Ho
Proponent: UMD, RPD, FWD
Evaluator: UMD (B. Smart); RPD (F. Horvath); FWD (G. Martin, A. Ghosh)
Contractor:
Category: 1 Review Panel: H5

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K	$100K	$90K	$250K

Earlier Directly Related Projects and Funding: 84.3.22
$49K $49K

4.104.1 Determination of Radon and Thoron Fluxes in Uranium Mines (Ontario) (85.3.10)

It is proposed to continue funding the study to measure the flux of radon and thoron gases emitted per unit surface area of stopes, airways and passageways of an underground uranium mine in Ontario.

The AECB has recently completed a research project (84.3.4) aimed at developing a computer model of underground mine ventilation networks. That model is made up of two parts. The first part of the model is used to determine the patterns of air circulation throughout the mine. The second part is designed to predict the concentrations of short-lived airborne radionuclides at given points of the ventilation network, for radiation protection purposes. The accuracy of those predictions depends on the quality of the information available on the characteristics of the sources of radon and thoron gases.

It is anticipated that systematic and accurate measurement of the characteristics of radon and thoron sources will enable the AECB to use the computer ventilation model to its full capabilities, and to carry out studies and verifications required by the Uranium Mine Division. (See 85.3.11.)

Project Manager: P.J. Dupert
Proponent: UMD
Evaluator: UMD (D. Corkill)
Contractor: Denison Mines Ltd.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$75K	$32K			$107K

4.105.1 Determination of Radon Fluxes in Uranium Mines (Saskatchewan) (85.3.11)

It is proposed to continue funding the study to measure the flux of radon gas emitted per unit surface area of stopes, airways and passageways of an underground uranium mine in Saskatchewan. (In contrast to uranium mines in the Elliot Lake region of Cntario, there are no sources of thoron gas in uranium mines in Saskatchewan.)

The AECB has recently completed a research project (84.3.4) aimed at developing a computer model of underground mine ventilation networks. That model is made up of two parts. The first part of the model is used to determine the patterns of air circulation throughout the mine. The second part is designed to predict the level of short-lived airborne radionuclides at given places of the ventilation network, for radiation protection purposes. The accuracy of those predictions depends on the quality of the information available on the characteristics of the sources of radon gases.

It is anticipated that systematic and accurate measurement of the characteristics of radon sources will enable the AECB to use the computer ventilation model to its full capabilities, and to carry out studies and verifications required by the Uranium Mine Division. (See 85.3.10.)

Project Manager: P.J. Duport
Proponent: UMD
Evaluator: UMD (D. Corkill)
Contractor: Senes Consultants Ltd.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$40K	$13K			$53K

4.106.2 Ontario Miners Mortality Study - Update (86.8.18)

It is proposed to continue funding the investigation of the cause of excess lung cancer among miners in Ontario, by updating the mortality analysis for Ontario uranium miners for the period from 1981 to 1984 and for gold miners from 1977 to 1984, in order to re-evaluate the risk of lung cancer per unit exposure of radiation.

This project is proposed because there is a need for an extension of the Phase II study (84.8.4) where excess lung cancer among gold miners and the influence of smoking on the incidence of lung cancer among uranium miners were investigated. The Phase II study recommended that the mortality analysis of gold miners should be extended from 1977 to 1984 to evaluate the impact of gold mining experience on the risk estimate for lung cancer among uranium miners.

It is anticipated that the results of the study will be used to improve the risk estimates for radiation-induced lung cancers. This is a joint project with the Workers' Compensation Board of Ontario and Ontario Ministry of Labour, which will contribute $94K to the project over the next two years.)

Project Manager: V. Elaguppillai
Proponent: Ontario Ministry of Labour, RPD, UMD, HRS
Evaluator: ACS (W.R. Bush); UMD (A.B. Dory); RPD (M. Measures)
Contractor: Ontario Ministry of Labour
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$22K	$25K		$47K

Earlier Directly Related Projects and Funding: 84.8.4

$159K	$31K	$180K

4.107.1 Development of a Radiation Safety Training Module for Use in Canadian Uranium and Thorium Mines (86.9.2)

It is proposed to continue funding the project to develop and produce a training module in radiation safety to promote a uniform standard of training for mine workers in Canadian uranium and thorium mines. This module is to be entitled Atoms and Nuclei. The topics of this module include: the different types of ionizing radiation; the properties and behaviour of uranium, thorium, radon and thoron and their daughter products, gamma, beta and alpha radiation. The emphasis will be on the development of a training course and training materials, leading to a better understanding of the health and safety of mine workers and given at a level which is understandable to them.

The module is to be designed to meet the standards and requirements set by the Atomic Energy Control Board's Uranium and Thorium Mining Regulations, made by the Board on 18 June 1986. The module will be a self-contained package including: training materials for each participant, a comprehensive guide for the instructor, training aids, laboratory exercises and an examination designed to test the knowledge acquired by the participants.

It is anticipated that the results will be used by the uranium mining licensees to satisfy some of the training requirements set out in the Uranium and Thorium Mining Regulations. In addition, a pilot project will be carried out to test the degree of understanding of the topics contained in the training module on a group of miners and mining supervisors during a licensee's regular training session in Elliot Lake and possibly at a Saskatchewan uranium mining facility.

Project Manager: K.P. Ho
Proponent: Canadian Institute for Radiation Safety, UMD
Evaluator: UMD (J. Viljoen)
Contractor: Canadian Institute for Radiation Safety
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$35K	$34K			$69K

4.108.1 Intercomparison of Instruments Used in the Determination of Size Distribution of Airborne Particles in Canadian Uranium Mines and Mills (86.3.1)

It is proposed to perform laboratory and field intercomparisons of instruments used to determine the size distribution of airborne particulate matter in all Canadian uranium mines and mills. Dust sampling instruments currently used by licensees for measuring uranium-bearing dust concentrations in the air will be tested against, and compared to, reference cascade impactors. Small-size personal respirable dust samplers (including 10 mm Cyclones and Campeds) will also be tested. The operating costs of these samplers will be evaluated.

This project is proposed because, in keeping with the recommendations of ICRP 30, the AECB is considering the use of a combined formula for calculating the Committed Effective Dose Equivalent received by uranium workers. The combined formula expresses exposure as the sum of the ratios of the exposures to each specific radiation hazard (gamma, radon progeny, thoron progeny, long-lived dust) to their respective annual limit of exposure or their annual limit on intake. The annual limit on intake for radioactive aerosols is, among other factors, a function of the particle size. It is therefore necessary to know the size distribution of the radioactive dust of concern to determine such parameters as ALI, DAC or Committed Effective Dose Equivalent. Consequently, it is necessary to determine which uncertainties routine dust samplers introduce in the measurement of exposure to radioactive dust.

It is anticipated that the results of this study will indicate how the dust measurements obtained from currently used instruments compare with measurements obtained from reference instruments. The influence of the size distribution of dust on instruments used routinely will be determined. This will assist the AECB in drafting guidelines for monitoring techniques and in evaluating codes of practice submitted by licensees.

Project Manager: K.P. Ho
Proponent: UMD, RPD
Evaluator: UMD (R. McCabe, W. McDonald); RPD (F. Horvath)
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K	$20K		$80K

4.109.1 Calibration of Wire Screen Collectors Used in the Measurement of Unattached Fraction of Radon and Thoron Progeny in Air (86.3.2)

It is proposed to continue funding the study to calibrate, experimentally, in the laboratory, a variety of wire screen aerosol collectors for measuring the unattached fraction of radon and thoron progeny in air. In addition, the theory and the semi-empirical laws governing aerosol collection and alpha counting characteristics on wire screen collectors will be developed.

This project is proposed because the complete deposition of the unattached fraction of radon and thoron progeny in the respiratory tract delivers 10 to 20 times more energy per unit mass of tissue than the attached fraction present in the atmosphere. The unattached fraction of radon and thoron daughters is highly variable, ranging from a few percent in diesel-powered areas of uranium mines, to more than 40% in non-mechanized areas and surface installations. Consequently, a complete evaluation of the radiological hazard presented by airborne radioactivity requires the knowledge of the unattached fraction. Wire screen aerosol collectors are the most convenient tools for measuring the unattached fraction; however, the characteristics of their collection efficiency and counting geometry have not been thoroughly investigated.

It is anticipated that the results of the study will fill a gap in knowledge regarding the accuracy of a crucial parameter in the measurement of ultrafine radioactive aerosols. They will also allow the Board staff to interpret more accurately airborne radioactivity measurements taken in uranium-producing facilities.

Project Manager: P.J. Duport
Proponent: HRS, RPD
Evaluator: RPD
Contractor: CERCL Ltd.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$22K	$50K	$18K		$90K

4.110.1 Modified Personal Alpha Dosimeter for Canadian Uranium Mines (86.3.5)

It is proposed to continue funding the modification of the measuring head of the personal alpha dosimeter developed by the French Atomic Energy Commission and used in some Canadian uranium mines and mills.

The modification is aimed at eliminating, or reducing substantially, spurious measurements of airborne radon and thoron decay products induced by the contamination of the internal parts of the measuring head by ultrafine long-lived radioactive dust particles.

It is anticipated that the modification, if it proves successful, will significantly improve the accuracy and reliability of individual exposure measurements to airborne radioactivity in high grade uranium mines and mills in Saskatchewan. (The Department of Energy, Mines and Resources has agreed to a contribution of $10K for FY 86/87 in addition to the AECB contribution for FY 86/87 shown below.)

Project Manager: P.J. Duport
Proponent: Canadian Institute for Radiation Safety, HRS, UMD
Evaluator: UMD
Contractor: CAIRS
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$15K	$29K			$44K

4.111.1 Uranium Mine Radiation Safety Course (87.9.1)

It is proposed to continue to fund the Uranium Mine Radiation Safety Course (UMRSC), at a reduced level. This continuing twice-a-year course sponsored by the AECB has been given since 1976.

This course is designed to provide participants with the basic understanding of radiological hazards to workers and to the environment. It also presents practical approaches to deal with these hazards. The philosophy and regulatory approach of the AECB are discussed.

It is anticipated that this course will provide a better understanding of uranium mine radiation safety principles to mine supervisors, inspectors and operations personnel, and to representatives from regulatory agencies, mining companies and unions, who are directly involved in uranium mine radiation safety.

Project Manager: K.P. Ho
Proponent: UMD
Evaluator: UMD (J. Viljoen)
Contractor: Canadian Institute for Radiation Safety
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
$64K	$90K	$50K			

4.112.1 Determination of the Electrical Charge of Radioactive Aerosols in Uranium Mines (87.3.1)

It is proposed to measure the fraction of positively and negatively charged aerosol particles carrying radon and thoron daughters, to determine the number of elementary charges carried by individual charged particles, and to relate these parameters to the ionization conditions and carrier aerosol parameters that prevail in underground uranium mine atmospheres.

The radiation dose delivered to the lung from inhaled radon and thoron daughters depends upon the deposition of these radioactive particles in the respiratory tract, which in turn depends on the size distribution and electrical charge of these particles. The aerosol size distribution itself is governed in part by the electrostatic attraction between ultrafine radon and thoron daughters and carrier aerosol particles generated by mining activities and diesel engines. Owing to the ionization induced by relatively large concentrations of alpha radiation emitters, the consequent phenomena (collectively referred to as "atmospheric electricity") play an important role in shaping the resulting radioactive aerosol actually inhaled by miners. To date, no study has been carried out in Canadian mines to determine the electrical properties of airborne radon and thoron daughters.

It is anticipated that the findings of this study will, for the first time, bring information to the AECB staff on the electrical state of radioactive aerosols in mines. This information may also be used in interpreting monitoring and dosimetry data and may serve to complement the computer modelling of mine atmospheres.

Project Manager: P.J. Duport
Proponent: J. Bigu (EMR), HRS
Evaluator: RPD
Contractor:
Category: 3c Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K	$30K		$90K

4.113.1 Tracer Gas Method for Assessing Ventilation Efficiency in Underground Uranium Mines and in Mills (87.3.2)

It is proposed to identify and test a tracer gas technique that is suitable for measuring ventilation rates in underground uranium mines and mills. Phase I of the work includes identifying portable, rugged, and easy-to-use equipment that can function in the underground mine and mill environments, and that allows several measurements to be made in a short period of time. Phase II includes the acquisition and testing of the equipment at selected sites in a mine and mill.

This project is proposed because in the performance of inspections of uranium mines and mills, AECB inspectors have encountered a number of situations where measurement of air flow directions or flow rates (for the purpose of evaluating the radiation protection efficacy of the ventilation system) has been difficult. Recent advances in the use of tracer gas techniques may be able to overcome the difficulties involved in performing these measurements in currently troublesome ventilation situations.

It is anticipated that a suitable tracer gas method (and related equipment) would permit AECB inspectors to evaluate more quickly and accurately the ventilation systems of mine and mill licensees.

Project Manager: P.J. Duport
Proponent: UMD
Evaluator: UMD (D. Corkill); RPD (S.H. Ching)
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K			$50K

4.114.1 Dust Removal from Uranium Mine Atmospheres by Means of Electrically Charged Water Spray (87.3.3)

It is proposed to test the effectiveness of the removal of aerosol particles of all origins from uranium mine atmospheres by means of ultrafine, highly charged water droplets generated by an "Air Jet Atomizer with Conductive-Inductive Charging". Such an air cleaning technique is used successfully in some industrial plants.

The largest fraction of radiation dose received by uranium mine workers comes from the inhalation of airborne alpha emitters, and the remaining comes from gamma radiation. Gamma radiation doses cannot be reduced in low grade uranium mines, because of the relative uniformity of uranium concentration in the rock. Therefore, any significant dose reduction will be achieved in reducing the air concentration of radioactive alpha emitters. In most of the mines, mechanical ventilation systems are already pushed to their maximum capabilities, and a recent study

commissioned by the AECB indicated that the use of industrial electrostatic air cleaners is not often practical in underground mines. A new and efficient dust removal technique has been used recently in industrial plants (smelters). It is based on the generation of an ultrafine, highly electrically charged water spray. Under electrostatic forces, aerosol particles collect the large number of elementary charges carried by the submicronic water droplets, and owing to the combination of air flow turbulence and electric image effect on the surrounding surfaces, aerosol particles are removed from the air. An underground mine seems ideally suited for that type of air cleaning mechanism.

It is expected that the results of the study will provide a complement to mechanical ventilation as a means of reducing radiation doses to workers in uranium mines. If proved successful, the proposed technique has an immediate potential for reducing radiation doses received by uranium workers.

Project Manager: P.J. Duport
Proponent: ERS
Evaluator: UMD
Contractor:
Category: 3c Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$70K	$50K		$120K

5. Waste Management

5.101.1 Verification and Validation for Waste Disposal Models (85.5.8)

It is proposed to continue a survey of the latest developments in methods for the verification and validation of modelling software. The survey would identify the best applicable methods for the testing of nuclear waste disposal software modelling systems.

AECB staff will be required to assess licensee submissions concerning the predicted performance of existing and proposed nuclear waste disposal facilities. Some of these performance predictions will be generated by software modelling packages currently under development by industry and government agencies. The validity of the modelling results is related directly to the effectiveness of the verification, validation and quality assurance methods used in model design and development.

The results of the survey will assist AECB staff in assessing the effectiveness of the verification and validation aspects of a particular model and hence the qualitative degree of confidence that may be assigned to the model's predictions.

Project Manager: D.E. Connelly
Proponent: SSS, WMD
Evaluator: SSS (D.E. Connelly); WMD (K.R. Shultz, S. Nguyen)
Contractor: INTERA Technologies Ltd.
Category: 1* Review Panel: S4

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$14K	$12K			$26K

5.102.1 Optimization in the Decommissioning of Uranium Tailings (85.5.9)

It is proposed to fund a project jointly with the National Uranium Tailings Programme. The project would survey the literature to determine optimization techniques which could be applied in the evaluation of decommissioning options for Canadian uranium mill tailings. For techniques which are identified to be so applicable, the project would also demonstrate precisely how each technique could be used in the evaluation of decommissioning options. This is a joint contract with NUTP which will contribute $30K in FY 86/87.

In the licensing process, the AECB requires optimization analyses to be performed, to ensure that exposures are as low as reasonably achievable (the ALARA principle). In relation to this process, the AECB requires information on techniques which may, in principle, be applied to the specific case of evaluating options for the decommissioning of uranium mill tailings.

The information obtained from the project would be used as input to the licensing process when evaluating licensee submissions relating to the decommissioning of uranium mill tailings.

Project Manager: D.J. Martin
Proponent: WMD, NUTP
Evaluator: WMD (B. Zgola)
Contractor: MacLaren Plansearch
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$25K	$5K			$30K

5.103.2 Waste Management Implications of Concentrating Slimes - II (86.5.1)

It is proposed to compile and review information on the management of uranium and non-uranium tailings in order to prepare a report suggesting methods for overcoming the problems of concentrating slimes identified in the first phase of this study (84.5.11).

Current plans call for backfilling uranium mines with the coarse fraction of tailings, leaving a residue of fines, or slimes. However, certain chemical, geological and mechanical problems arise from concentrating the slimes. The AECB needs to be apprised of any proven, or even well-conceived but as yet non-implemented, techniques for dealing with these problems.

It is anticipated that the results of this work will provide the AECB with a compiled source of information which can be used in evaluating operating and decommissioning proposals by licensees.

Project Manager: J.L. Wallach
Proponent: WMD/UMD
Evaluator: WMD (B. Zgola); UMD (A.B. Dory)
Contractor: Beak Consultants Ltd.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$15K	$10K			$25K

Earlier Directly Related Projects and Funding: 84.5.11
$25K $25K

5.104.1 State-of-Stress and Groundwater Flow (86.5.2)

It is proposed to continue the use of existing boreholes at the Roblindale Quarry in order to monitor groundwater flow directions and rates in the underlying Precambrian granite.

This study is proposed in order for the AECB to acquire independent information on the flow of groundwater through fractures in plutonic rock. It is also being proposed to determine whether the predominant flow direction is in any way related to the orientation of the ambient principal stresses at the quarry.

The results of this study would be used to evaluate information on groundwater flow which will be submitted to the AECB as part of the Concept Assessment phase of the Canadian Nuclear Fuel Waste Disposal Program.

Project Manager: J.L. Wallach
Proponent: SSS
Evaluator: SSS (J.L. Wallach); WMD (P.A. Flavelle)
Contractor: Fracflow Consultants Inc.
Category: 1* Review Panel: S1

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$48K	$7K			$55K

5.105.1 Performance of Engineered Barriers for Low-Level Wastes (86.5.3)

It is proposed continue with a literature review to synthesize and interpret the information available on the performance of engineered barriers used in the disposal of low level wastes.

At the present time, simple assumptions about the waste form and surrounding barriers are often used in modelling and safety assessment studies. However, the consequences of various release mechanisms and exposure pathways are likely to be sensitive to variations in the properties of the engineered barriers. Of particular interest is the transport of water and radionuclides through the barriers and how this changes with time as a result of degradation under shallow burial conditions in representative regions of Canada.

It is anticipated that the results of the literature review and synthesis will be of use to AECB staff in decisions relating to the long-term performance of barriers in waste storage facilities, nuclear facilities undergoing decommissioning, and waste disposal facilities.

Project Manager: J.L. Wallach
Proponent: WMD
Evaluator: WMD (K.R. Shultz, M. White)
Contractor: Geotechnical Resources Ltd.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$25K	$7K			$32K

5.106.1 Methodology for Estimating Probabilities of Intrusion (86.5.4)

It is proposed that a generic methodology be developed for estimating the probabilities of intrusion scenarios for different types of waste management facilities. The methodology would take into account inter alia burial depth, location, current and projected land-use patterns and facility design.

Inadvertent human intrusion is an issue that is raised when considering nuclear fuel waste disposal, low-level waste disposal and uranium tailings management, yet there is no consensus on how it should be addressed by either regulators or licensees.

It is anticipated that the results of the study would be used in giving guidance to licensees in conducting safety and performance assessments and in applying regulatory criteria. The study when factored into the licensing process for waste management facilities would serve to clarify the need for, and length of time required for, institutional controls and various types of land-use restrictions.

Project Manager: J.L. Wallach
Proponent: WMD
Evaluator: WMD (K.R. Shultz)
Contractor: Beak Consultants Limited
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$13K	$8K			$21K

5.107.1 Erosion of Surface and Near-Surface Disposal Facilities (86.5.7)

It is proposed to continue with the evaluation of available information on the erosion of naturally occurring, unconsolidated sediments in order to estimate the length of time that surficial and near-surface disposal facilities are likely to resist erosion and prevent the release of unacceptable concentrations of radioactive materials.

This study is proposed because, to date, certain licensees consider only uniform sheet erosion when estimating the length of time that a disposal facility will provide adequate containment of radioactive waste. However, because of the rapidity of some erosional processes relative to sheet erosion, such as gully formation, it is suspected that containment may not be maintained for as long a period of time as currently claimed by the licensees.

The results of this program will be used in determining the acceptability of the approach currently adopted by the licensees regarding the erosion of surface and near-surface waste disposal facilities. The results may also indicate whether guidelines specifically addressing this phenomenon should be written.

Project Manager: J.L. Wallach
Proponent: WMD
Evaluator: WMD (K.R. Shultz, P. Flavelle)
Contractor: MacLaren Plansearch Inc.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$12K	$6K	$70K		$88K

5.108.2 Plotting for a Groundwater Flow/Contaminant Transport Model (86.5.8)

It is proposed to initiate a two-phase project involving plotting post-processing, tailored to AECB requirements, for the groundwater flow and contaminant transport model FEMWATER/FEMWASTE. This project would be dependent on the outcome of project 85.5.3, "Survey of Computer Codes for Flow and Contaminant Transport". Phase I would review the AECB

requirements, evaluate the various solutions available and recommend a particular approach. Phase II would implement, in response to the AECB requirements, any software solutions recommended in Phase I. (Note that if Phase I simply recommended the purchase of plotting hardware compatible with existing FEMWATER/FEMWASTE plotting routines then Phase II would not be required.)

The existing plotting routines of FEMWATER/FEMWASTE are designed to interface with calcomp plotters and are apparently not compatible with the AECB's Hewlett-Packard plotters. Also, the existing FEMWATER/FEMWASTE plotting software may not be effective in representing the transport of the radioactive waste inventory for the Canadian site configurations to be assessed. Plotting of results is essential to enable AECB staff to effectively visualize and interpret the complex performance characteristics of a radioactive waste disposal facility.

The results of this project would improve the effectiveness with which AECB staff could use FEMWATER/FEMWASTE to assess licensees' performance predictions for existing and proposed waste disposal facilities.

Project Manager: D.E. Connelly
Proponent: WMD, SSS
Evaluator: WMD (S. Nguyen)
Contractor: CUBE Systems Consulting Services Inc.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$9K	$9K			$18K

Earlier Directly Related Projects and Funding: 85.5.3

$6K	$32K				$38K

5.109.1 Sensitivity Study of the Concept of Deep Geologic Disposal (86.5.9)

A project is proposed to determine the most significant factors affecting the risk from the deep geologic disposal of nuclear fuel waste, based on a sensitivity analysis of the risk calculation. The analysis should begin with the sensitivity of the final result to the variation in major calculation segments. The sensitivity of the important major segments and their respective sub-segments to input variables will be investigated. This is a "top down" approach, with each analysis progressively more detailed.

Current assessments of deep geological disposal are carried out using a large, complex computer model, SYVAC, to do a Monte Carlo analysis of the post-closure risk to the public. The AECB needs to take a broad look at the major sub-systems and processes to determine the overall effects they may have on the risk predictions. Also, with several hundred input parameters in a model, it is necessary but very difficult to identify which parameters are important (or even limiting) to the risk calculation.

The results of this research will allow Board staff: a) to direct their evaluation of the concept assessment to the most important areas (sub-systems, processes, pathways, parameters and correlations); b) to set the criteria to judge the adequacy of the information, understanding, models and database in a particular area; and c) to evaluate the significance of the various components in the risk calculation done using SYVAC.

Project Manager: D.J. Martin
Proponent: WMD
Evaluator: WMD (K. Bragg)
Contractor: Beak Consultants Ltd.
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$25K	$5K			$30K

5.109.2 Analysis of the Concept of Deep Geologic Disposal (87.5.7)

It is proposed to continue studies begun on the most significant factors affecting the risk from the deep geologic disposal of nuclear fuel waste. Phase I (Project 86.5.9) evaluated the factors in a general way, identifying key items which merited further work. This project would analyze in greater depth these key items.

Current assessments of deep geological disposal are carried out using a large, complex computer model, SYVAC, to do a Monte Carlo analysis of the post-closure risk to the public. The AECB needs to take a broad look at the major sub-systems and processes to determine the overall effects they may have on the risk predictions. Also, with several hundred input parameters in a model, it is necessary but very difficult to identify which parameters are important (or even limiting) to the risk calculation.

The results of this research will allow Board staff: a) to direct their evaluation of the concept assessment to the most important areas (sub-systems, processes, pathways, parameters and correlations); b) to set the criteria to judge the adequacy of the information, understanding, models and database in a particular area; and c) to evaluate the significance of the various components in the risk calculation done using SYVAC.

Project Manager: D.J. Martin
Proponent: WMD
Evaluator: WMD (K. Bragg)
Contractor:
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K			$60K

Earlier Directly Related Projects and Funding: 86.5.9
$25K $5K $30K

5.110.2 Measurement of Thorium Concentration in Fish: A Field Study (87.4.3)

In areas where uranium mine tailings contain significant amounts of pyrite, thorium isotopes may be remobilized and, therefore, move into the environment. It is proposed to undertake a field study to determine the concentration of these radionuclides in fish and their associated water and sediments.

The AECB recently commissioned a review of the scientific literature (86.4.7) to determine the extent and quality of information concerning the uptake of U-nat, Ra-226, Th-232, Th-230, and Th-228 by fish. Preliminary results of the survey show that a lot of data exist on the uptake of uranium and radium. If the review confirms that information on thorium is sparse there will be a need to carry out a field study.

The information from this project would be used to determine whether thoriums should be included in the calculation of release limits for effluents from uranium mines and mills.

Project Manager: R. Avadhanula
Proponent: WMD
Evaluator: WMD (B. Zgola)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$45K			$45K

Earlier Directly Related Projects and Funding: 86.4.7
$25K $25K

5.111.1 Effective Communication with the General Public (87.4.6)

A project is proposed to identify problems involved in communicating to the general public the technical information associated with the disposal of radioactive waste. Problems of misconceptions, which social issues to include in discussions, what the public expects of regulators in terms of responsibilities and information to be provided, etc., are to be considered. This study would be done in two phases. Phase I would consist of identifying material and concerns to be addressed with emphasis on those to be addressed in a regulatory context. Phase II would, from the regulatory perspective, address the findings of Phase I.

In June 1978, the governments of Canada and Ontario responded to concerns of the public and the nuclear industry by initiating a program "to dispose of radioactive waste from nuclear power reactors" safely in a deep, underground repository in intrusive igneous rock. AECL and OH were given responsibility for research. Subsequently in August 1981 the Canada-Ontario joint statement announced, inter alia, that the AECB would be the lead agency for the regulatory review of a ten-year Nuclear Fuel Waste Management Program to examine the feasibility of deep geological disposal for high level waste, a "concept assessment" of a "disposal system", prior to any actions related to disposal.

This project would: a) better prepare AECB staff for participation in forthcoming public hearings; and b) enhance the ability of AECB staff to understand and communicate regulatory requirements and may identify the need for additional requirements.

Project Manager: D.J. Martin
Proponent: WMD
Evaluator: WMD (K. Bragg)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$40K			$40K

5.112.1 Remeasurement of Th-230 in the Pore Water of Lacnor Tailings (87.5.1)

It is proposed to remeasure the Th-230 concentrations in the pore water of the Lacnor tailings. The remeasurement program will include a comprehensive quality assurance programme.

This study is proposed because the concentrations, determined from previous measurements, vary with the laboratory in which the measurements were made. Consequently, reliable information on the environmental behaviour of Th-230 is not yet available.

The information concerning the environmental behaviour of Th-230 will be used to assess whether there is a need to include Th-230 in derived release limit calculations or in decommissioning submissions made by uranium mine and mill operators.

Project Manager: R. Avadhanula
Proponent: WMD
Evaluator: WMD (B. Zgola)
Contractor:
Category: 1 Review Panel: S3

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K			$50K

5.113.1 Non-Radioactive Contaminants in Uranium Raffinates (87.5.2)

As an initial step in investigating the regulatory implications of the presence of non-radioactive contaminants in uranium mill tailings and refinery wastes it is proposed to review the scientific literature concerning the environmental behaviour of contaminants such as arsenic and nickel.

The mining, milling and refining of uranium increase the availability of non-radioactive contaminants to the environment. Because this is an impact of the uranium fuel cycle there is a need for AECB staff to be aware of the environmental behaviour and fate of these materials.

The information gathered by this project will be used to establish whether the measures proposed by the licensees to reduce the movement of non-radioactive contaminants from tailings and waste management areas are acceptable.

Project Manager: R. Avadhanula
Proponent: WMD
Evaluator: WMD (B. Zgola)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$30K			$30K

5.114.1 Installation of SYVAC III on AECB Computer (87.5.3)

It is proposed to install a computerized model, SYVAC III, on a computer system accessible to the AECB staff.

AECB staff will soon be called upon to perform technical assessments of the high level waste disposal programme. In order to complete this assessment it will be necessary to use and examine in detail the computer model with which the behaviour of the facility and its contents are predicted. This would be most efficiently done by installing the code on a computer available to AECB staff.

The installed computer code would be a major component of the technical assessment to be carried out by AECB staff on the deep geological programme.

Project Manager: D.E. Connelly
Proponent: WMD
Evaluator: WMD (K. Bragg)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$20K			$20K

5.115.1 Software Quality Assurance for Waste Disposal Models (87.5.4)

It is proposed to survey the latest developments in quality assurance programmes for software as applied to modelling. The survey would identify the best applicable methods for assuring the quality of software systems to be applied to nuclear waste disposal.

AECB staff will be required to assess licence submissions concerning the predicted performance of existing and proposed nuclear waste disposal facilities. Some of these performance predictions will be generated by software modelling packages currently under development by industry and government agencies. Confidence that all of the requirements associated with model design, development and testing have been identified and implemented, is dependent on the effectiveness of the software quality assurance programme.

The results of the survey will assist AECB staff in assessing the effectiveness of the quality assurance programme to be applied to a particular model and hence the degree of confidence associated with how the model will perform.

Project Manager: D.E. Connelly
Proponent: CQAD, WMD
Evaluator: CQAD (D. Scrimger); WMD (P. Flavelle); SSS (D.E. Connelly)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$20K			$20K

5.116.1 Development and Administration of UTAP Training Workshop (87.5.5)

The culmination of the NUTP program was the production of the model UTAP. However, before a comprehensive program to train potential users of UTAP could be developed, the NUTP was disbanded. Thus it is proposed to develop and hold a workshop for potential users of the NUTP model UTAP.

The model UTAP is a probabilistic model that describes the movement of radionuclides from uranium tailings to humans. It requires the user to be familiar with the data requirements, the format and content of the output, and the operational capabilities of the model in order to make effective use of it. By attending a hands-on workshop run by the authors of the model, the potential users could obtain the necessary skills and information to use UTAP.

The model UTAP is to be used to evaluate licensee submissions. Having the expertise in-house means that evaluations can be done in a timely and independent fashion.

Project Manager: D.J. Martin
Proponent: WMD
Evaluator: WMD (B. Zgola)
Contractor:
Category: 3c Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$30K			$30K

5.117.1 Summary of Results from the National Uranium Tailings Program (87.5.6)

A project is proposed which would provide a detailed description of the results of the National Uranium Tailings Program (NUTP). The project would describe and document precisely the UTAP model, its limitations, strengths, weaknesses, and describe what was achieved by the NUTP.

The NUTP will be terminated at the end of FY 86/87, with some useful work still to be done. A report which documents what was achieved would be of great use in the future.

The results of the project would be of help in future use of the UTAP model, by providing an indication of the strengths, weaknesses, and limitations of the model. Also a description of what was achieved by the NUTP would be of help in assessing what may yet require to be investigated in the field of uranium tailings management.

Project Manager: D.J. Martin
Proponent: WMD
Evaluator: WMD (B. Zgola)
Contractor:
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$70K			$70K

6. Non Fuel Cycle Applications

6.101.1 Doses from Portable Gauges (86.6.2)

It is proposed to continue funding the study to determine the doses received by operators of portable moisture-density gauges under various working conditions.

This study was proposed because the AECB has approximately 450 licensees who use portable moisture-density gauges. Currently, operators are not required to wear TLDs because the doses are normally low. However, depending upon the amount of use, the operator's procedures and the number of times a portable gauge has to be cleaned, the accumulated doses for individuals might become significant.

It is anticipated that the results of this study will provide information to the AECB to determine whether present operating procedures require changes and whether it is necessary for operators of portable gauges to wear TLDs.

Project Manager: K.P. Ho
Proponent: RTD
Evaluator: RTD (W.R. Brown)
Contractor: Atomic Energy of Canada Ltd. (CRNL) - S. Linauskas
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$30K	$19K			$49K

6.102.1 Radiation Doses to Technologists from Radiotherapy Treatment Procedures (86.6.4)

It is proposed to measure and compare the radiation doses received by radiotherapy technologists during the performance of their duties at three different treatment machines. In addition, doses to these technologists from sources implanted in patients will be assessed. The three types of treatment machines are: cobalt-60 teletherapy unit, high energy linear accelerator (20 MeV), and low energy linear accelerator (4 MeV). Typical exposure values will be derived on a per-treatment basis for the more common treatment types, as well as on a weekly basis for each of the treatment machines included in this study.

This work is proposed because, in order to reduce the radiation exposure received by technologists in a radiotherapy department, it is necessary to identify the significant sources of exposure and their relative magnitudes. Also, the radiation exposures attributed to technologists may vary from machine to machine implying that there may be significant differences in exposure at the various machines. This study will measure the variations in exposures from machine to machine and assess the exposures and doses from implanted sources.

It is expected that the proposed research will provide information on the relative exposure received by technologists working on the different types of therapy machines and on patients who have implanted sources. From this information, the AECB may be able to infer the mechanism by which the technologists receive the major part of their personal exposures. This information is essential in order to effect changes aimed at reducing personal radiation exposures, including the re-assignment of pregnant technologists to those duties where exposure is minimized as well as to develop new patient set-up techniques and protocols aimed at reducing the radiation exposure to the technologists.

Project Manager: K.P. Ho
Proponent: RTD
Evaluator: RTD (W.R. Brown)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$25K			$25K

6.103.1 Feasibility of Using Beta-Gamma Counting of Ra-228/Ac-228 in Urinalysis (87.6.1)

It is proposed to fund a project to determine experimentally the feasibility of using beta-gamma counting of Ra-228/Ac-228 as a means of routine urinalysis for thorium.

This project is being proposed because, while there are several dozen workers (e.g., thorium mantle workers and uranium mill workers in Elliot

Lake) occupationally exposed to thorium, present urinalysis measurements for thorium are done by colourimetric analysis whose sensitivity is about 20 micrograms/l, which is inadequate for a routine bioassay program for thorium.

It is anticipated that the results of this study will determine whether the proposed beta-gamma counting for Ra-228/Ac-228 can provide significant improvement in sensitivity over the present chemical process (i.e. colourimetric analysis) and also whether the proposed beta-gamma counting method can be used for a routine bioassay program.

Project Manager: K.P. Ho
Proponent: RPD
Evaluator: RPD (C. Pomroy)
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K			$50K

6.104.1 Production of a Hospital Radiation Safety Officer's Handbook (87.6.2)

It is proposed to produce a handbook for use in Canadian hospitals by the hospital Radiation Safety Officer (RSO).

This work is proposed because the AECB has recently amended the policy regarding the uses of radionuclides in hospitals and has restated the role of the RSO. As a result, the certification of Registered Technologist of Nuclear Medicine (RTNM) is now considered as sufficient proof of competence for a RSO position.

It is anticipated that the production of this handbook will be used as a reference manual by Radiation Safety Officers and that the manual will contain diverse technical and regulatory information useful in the daily activities of a RSO. This project will be funded jointly with DSS. Their contribution will be provided in FY 87/88 and it is to be 50% (approximately $15K) of the project cost; the AECB will contribute the remaining 50% in FY 88/89 for a total project cost of approximately $30K.

Project Manager: K.P. Ho
Proponent: RTD
Evaluator: RTD (W.R. Brown); RPD (R. Irwin)
Contractor:
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
			$15K		$15K

7. Health Physics

7.101.1 The Canadian National Dose Registry Study (84.8.10)

It is proposed to continue funding the project to conduct an epidemiological study of cancer mortality among some 300,000 Canadians occupationally exposed to low levels of ionizing radiation, by developing a suitable linkage between the Canadian National Dose Registry and the Canadian Mortality Data Base.

This study is intended to find out whether there is any excess cancer mortality among certain groups of workers, such as Nuclear Medicine Technicians and Radiographers, who have not been studied so far in sufficient detail. This study of 300,000 radiation workers is likely to provide further information towards a better understanding of the dose-response relationship for low doses of ionizing radiation.

It is anticipated that the results of this study will be used to verify risk estimates for radiation-induced cancer mortality. (A joint study with the Department of National Health and Welfare and Statistics Canada.) NHW has expended considerable resources both in dollars and man-years in support of this project. The expenditure by NHW is in addition to the funds expended by the AECB.

Project Manager: K.P. Ho
Proponent: P. Ashmore (NHW), HRS, M. Smith (Statistics Canada)
Evaluator: RPD (M. Measures)
Contractor: Statistics Canada
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
$124K	$60K	$45K	$65K	$90K	$384K

7.102.1 Measurement of the Thickness of Bronchial Epithelium (84.8.14)

It is proposed to continue support for the project to measure the depth of basal cells and the thickness of cilia and mucous layers covering the human epithelium of the tracheo-bronchial region to identify the cells that make up the epithelial walls, and to indicate their relative number in the cell population. Measurements of the various parameters will be made on biopsy and autopsy samples.

The study is expected to improve the accuracy of the various anatomical parameters used in lung dose calculations. Currently available data on the above anatomical parameters are based only on a single study which is known to have many uncertainties.

It is anticipated that the more accurately determined parameters obtained from this study will be used in the calculation of lung doses

due to inhaled radon and thoron daughters and long-lived radioactive dust.

Project Manager: E. Rabin
Proponent: RPD, HRS
Evaluator: RPD (F. Horvath, C. Pomroy)
Contractor: University of Manitoba - Dr. D.H. Bowden
Category: 1* Review Panel: H7

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$39K	$58K	$19K		$116K

7.103.2 Measurement of RBE for Tritium for Myeloid Leukemia (84.8.15)

It is proposed to continue funding the laboratory experiment to measure the Relative Biological Effectiveness for tritium beta rays for the induction of myeloid leukemia in mice.

The study was proposed because of the concern as to whether or not a given dose of tritium beta rays is equally as effective as the same dose of 200 kVp X-rays, delivered at the same dose rates, for the induction of myeloid leukemia. A feasibility study completed in FY 84/85 has recommended a full-scale 5-year study on CBA/H mice. Note: Due to the breakdown of the 300 kVcp generator, the study is being performed using a suitably filtered 150 kVcp X-ray beam. This is not anticipated to undermine the validity of the results.

It is anticipated that the results of the study will improve the estimate of the quality factor (QF) for tritium beta rays. (A joint study with AECL, Ontario Hydro, Hydro Quebec and NBEPC. The total cost of the study is $1,221.7K and the AECB share is $335K, AECL $574.3K, Utility Group $312.4K.)

Project Manager: E. Rabin
Proponent: RPD, HRS
Evaluator: RPD (C. Pomroy)
Contractor: AECL-CRNL
Category: 1* Review Panel: H6

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
$23K	$63K	$64K	$80K	$105K	$335K

Earlier Directly Related Projects and Funding: 84.8.15
$7K $7K

7.104.1 Revision of Name-Encoding Scheme (NYSIIS) for Use by Canadian Epidemiological Studies (85.8.6)

It is proposed to continue the funding of this project which is examining the feasibility of revising the currently used computer code of a name-encoding scheme (NYSIIS) for Canadian names and phonetics using Ontario miners' mortality data.

A number of epidemiological studies of radiation-induced cancers reveal that 2-10% of mortality searches are lost because the currently used name-encoding scheme developed by New York State (NYSIIS) is inadequate for certain Canadian surnames. A revised name-encoding scheme might therefore be necessary to improve the accuracy of the mortality search.

The results of the study would be used to determine whether or not a revised name-encoding scheme should be developed and used in all Canadian epidemiological studies of radiation-induced cancers.

Project Manager: K.P. Ho
Proponent: HRS, M. Smith (Statistics Canada)
Evaluator: RPD
Contractor: Statistics Canada
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
$14K	$39K	$24K			$77K

7.105.1 Epidemiological Study of Radiation-Induced Developmental Defects among Canadians (85.8.7)

It is proposed to continue funding the pilot epidemiological study of teratogenic (non-inherited) defects among Canadians who received in utero irradiation. (Cancer is not considered to be a developmental defect.)

With the revision of dose limits for female atomic radiation workers increasing numbers of young women are expected to seek employment in the nuclear industry and in other activities where exposure of an embryo or fetus may occur. This exposure may result in increased incidence of radiation-induced developmental defects. The currently available risk estimate of 10^{-1} per Sv for developmental defects has a number of uncertainties associated with it and, therefore, further studies are needed. No comprehensive epidemiological study has ever been undertaken in Canada to obtain this additional information which would improve the risk estimates for radiation-induced developmental defects.

It is anticipated that the results of the study will enable the AECB to determine the feasibility of a full-scale study. Such a full-scale study, if it is feasible, is likely to result in the improvement of risk estimates for radiation-induced developmental defects.

Project Manager: V. Elaguppillai
Proponent: RPD, HRS
Evaluator: RPD (C. Pomroy)
Contractor: University of British Columbia - Dr. T. Anderson
Category: 1* Review Panel: H1

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$25K	$37K			$62K

7.106.2 Full-Scale Study of Health Effects on Central Nervous System following In Utero Exposure (85.8.13)

It is proposed to fund a full-scale study of the health effects on the central nervous system (CNS) of experimental animals (rats and monkeys) following in utero exposure to ionizing radiation at different stages of gestation.

It is anticipated that an increasing number of young women will seek employment in the Canadian nuclear industry, where, in some cases, exposure of embryos or fetuses may occur. Very little information is available in the literature about the effect of in utero irradiation on the function and structure of the central nervous system. A feasibility study (84.8.8) completed in 1986 recommended a full-scale study to make quantitative estimations of the risk of health defects on the CNS following in utero irradiation taking dose, dose rate, and the stage of gestation into account. The Review Panel is also awaiting the results of 85.8.7 from which neuro-histological information (from humans) is needed in order for the present study to commence.

The results of the full-scale study will be used to improve risk estimates for radiation-induced developmental defects.

Project Manager: V. Elaguppillai
Proponent: RPD, HRS
Evaluator: RPD (F. Horvath)
Contractor:
Category: 3b Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$150K	$150K		$300K

Earlier Directly Related Projects and Funding: 84.8.8
$22K $22K

7.107.1 A Feasibility Study on the Identification and Determination of Exposure Levels of Non-Radiological Carcinogenic Substances at Canadian Nuclear Facilities (85.8.15)

It is proposed to continue the funding of this feasibility study which involves identifying and determining the occupational exposures to non-radiological substances at a number of Canadian nuclear facilities (e.g., Whiteshell Nuclear Research Establishment, Pickering Nuclear Generating Station, Eldorado Resources Ltd., Canadian General Electric Co.).

This study is being proposed because workers at Canadian nuclear facilities might be exposed to a number of non-radiological carcinogens. These carcinogens and their concentrations have not been accounted for in a number of epidemiological studies as potential factors in the induction of cancer among radiation workers. Before these carcinogens are properly accounted for in epidemiological studies, it is necessary to identify them and to determine their concentrations in the current radiation working environment. These concentrations may also provide the basis for historical estimates (of the concentrations of these carcinogens) relevant to the period of the epidemiological studies.

It is anticipated that the results of the study will demonstrate whether or not it is feasible to identify and to determine the concentrations of non-radiological substances at Canadian nuclear facilities. This should enable the AECB to carry out epidemiological studies on the potentiation of non-radiological substances as possible synergistic factors in the induction of cancer among workers in the current radiation working environment. (The original project 85.8.5 has been divided into two projects 85.8.15 and 85.8.16.)

Project Manager: K.P. Ho
Proponent: RPD, HRS
Evaluator: RPD (M. Measures)
Contractor: Atomic Energy of Canada Ltd. (WNRE) - A. Petkau
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
$4K	$37K	$5K			$46K

7.108.1 Standardization of Individual Identifying Information for Health Record Keeping Methodology (85.8.16)

It is proposed to continue the funding of the development and evaluation of a standard health record keeping methodology for employees of AECB licensees. This methodology will provide a standard for the collection of adequate individual identifying information to facilitate long-term follow-up of licensees' employees exposed to radiological and non-radiological hazardous agents for detection of possible health risks or delayed harm. The methodology will then be tested and evaluated by means of a pilot project, with a view to recommending procedures for the implementation, update, and maintenance of information related to individual identifiers.

This project is proposed because adequate personal identification captured and stored in a cost-effective retrievable form will facilitate future follow-up studies. Presently, it is often found during the linkage of data files in epidemiological studies (including AECB-sponsored investigations, such as the Newfoundland Fluorspar Miners and the National Dose Registry studies) that inadequate individual identifying information is being maintained for current and past employees. The absence of complete, as well as a sufficient number of, identifiers makes it difficult and costly, or in many other cases impossible, to carry out long-term follow-up and record linkage studies for detection of health risks. The pilot project, for the testing and evaluation phase, is being proposed because it will ensure that the design, documentation and procedures developed are sufficient for the implementation and maintenance of a health record keeping system for AECB licensees who supply information on radiation doses to the National Dose Registry. The pilot project is expected to be carried out in collaboration with a licensee, likely Atomic Energy of Canada Limited.

It is anticipated that the results of the study will facilitate and encourage adequate on-going individual record keeping for the preparation of current and past employee nominal rolls. Since a standard record keeping methodology will make all licensees' files compatible, data analyses among the various files should not only be cheaper and more thorough, but also comparable. The standard methodology should facilitate periodic epidemiological studies, for example, as study populations age. It may also allow the study of synergisms among radiation and chemical agents, or among radiation and other factors (medical history, lifestyle, geographic location, etc.). The results may also form the basis of an unambiguous identification of the individual in conjunction with the collection of radiological and non-radiological exposure histories and work histories. These will allow for subsequent follow-up, by the AECB, of health outcomes (mortality, morbidity, and genetic effects) and will be of use for reporting purposes to registries (dose, exposure or disease), and for other legislative or regulatory requirements. (The original project 85.8.5 has been divided into two projects 85.8.15 and 85.8.16.)

Project Manager: K.P. Ho
Proponent: HRS, M. Smith (Statistics Canada)
Evaluator: RPD
Contractor: Statistics Canada
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
$24K	$37K	$17K			$78K

7.109.1 Epidemiological Study of Genetic Disorders in Adults (85.8.18)

It is proposed to continue funding the epidemiological study of genetic disorders among adults in British Columbia. Genetic disorders among a cohort of nearly 20,000 persons born before 1952 will be analyzed using the most recent classification codes.

This study is complementary to the earlier British Columbia study of childhood genetic defects among a cohort of nearly 60,000 individuals born between 1952 and 1982. The earlier AECB-funded study was completed in FY 85/86 with the recommendation that adulthood genetic defects among those born prior to 1952 should also be investigated to minimize any bias of underestimating the risk of radiation-induced genetic defects.

It is anticipated that the results of the study will improve the risk estimates for radiation-induced genetic disorders.

Project Manager: V. Elaguppillai
Proponent: RPD, HRS
Evaluator: RPD
Contractor: University of British Columbia - T.W. Anderson
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$20K	$50K			$70K

7.110.1 Screening of Human Populations for Abnormal Radiosensitivity (85.8.20)

It is proposed to continue funding the project which is intended to develop a relatively inexpensive and rapid assay to screen for inherited differences in radiosensitivity of individuals.

This project was proposed because in recent years, there has been "increasing recognition that there are human genotypes that confer both increased cancer risk and abnormal cellular sensitivity on exposure to carcinogenic agents, including ionizing radiation". Subgroups of human populations possessing these genotypes affect the distribution of risk. Depending on the degree of heightened sensitivity, the average dose-response relationship may significantly underestimate the risk for

low dose or low dose-rate exposure of the sensitive individuals. The carriers of the "defective" genotypes are often not identifiable by common clinical tests. An ability to detect such persons on an occupation-wide basis could lead to improved protection for radiation workers and greater comprehension of how risk is distributed. An appreciable side-benefit could accrue from the practical application of such a screening assay: persons identified as "normal" would be somewhat less at risk than was previously supposed. The principle of such an assay currently exists in the cultured fibroblast, colony-forming ability assay. However, the fibroblast assay is too labour-intensive and expensive (estimated cost approximately $5,000 per strain (assay procedure) to test for sensitivity to ionizing radiation) to be used in screening large numbers of persons, and additionally too slow (establishment of the primary culture and survival analyses can take 6 to 8 months).

It is anticipated that the results of this study will lead to a technique for routine screening for inherited differences in radiosensitivity of subpopulations of radiation workers and others. Information obtained from routine screening of these subpopulations may impact upon the exposure-risk estimates currently forming the basis for the AECB occupational limits for exposure to ionizing radiation owing to a necessary re-evaluation of the distributions of risk derived from epidemiological studies. (A joint study with AECL on an equal cost sharing basis.)

Project Manager: E. Rabin
Proponent: RPD, HRS
Evaluator: RPD
Contractor: Atomic Energy of Canada (CRNL) - Gentner & Morrison
Category: 1* Review Panel: H8

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$75K	$114K	$83K		$272K

7.111.1 In Vitro and In Vivo Studies of the Effects of Ionizing Radiation on the Developing Central Nervous System (85.8.22)

It is proposed to fund the in vitro and in vivo studies of the effects of exposure to external gamma radiation on the developing central nervous system of rat and monkey embryos, using whole embryo culture.

It is anticipated that an increasing number of Canadian women will seek employment in the nuclear industry, where, in some cases, exposure of embryos or fetuses may occur. Although mental retardation has been found to be the major developmental defect among those who received in utero exposure in the nuclear explosion in Japan, very little information is available in the literature about the effect of radiation on the function and structure of the brain. This study will help in the understanding of the problem.

It is anticipated that the results of the study will assist in the quantification of the risk of in utero exposure to ionizing radiation on the developing central nervous system. (This is a joint project with the University of Manitoba and the Children's Hospital Research Foundation of Manitoba, which will contribute $160K to the project over the next three years.)

Project Manager: V. Elaguppillai
Proponent: RPD, HRS
Evaluator: RPD (F. Horvath)
Contractor:
Category: 1 Review Panel: H1

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$55K	$51K		$106K

7.112.1 Development of a Dosimetry Database for Atomic Radiation Workers in Canada (86.3.3)

It is proposed to develop a dosimetry database for Atomic Radiation Workers in Canada. The contractor will design and produce an operational database that contains all necessary information and analytical procedures to permit the AECB to perform statistical and time series analyses of exposure and dose records using the AECB computer system.

This project is being proposed because there has been very little work done to date with respect to analyses of these exposure and dose data. Moreover, exposure and dose data received from the licensees by the AECB are in printed form, a form which is not easily amenable to trend analyses or calculation of statistical parameters. Exposure and dose information in the National Dose Registry is oriented toward individual records with little characterizing information, thus of very little use in identifying and analyzing groups of workers by sector within the nuclear industry, by specific nuclear facility, or by licensee. There will, therefore, be no duplication between the uses of this database and that of the National Dose Registry.

It is anticipated that analyses by AECB staff of the records to be included in the computer database for such workers will enable the AECB to have up-to-date information on the radiological conditions that prevail at the various nuclear facilities and for the various types of occupational groups. Distributions of exposures and doses by occupational group, nuclear facility type, etc., as well as individual and collective long-term exposure and dose trends should become known by these means, along with some information required for further reducing the radiation risks to these groups. The part of the database consisting of the exposure and dose records of uranium mine workers will likely be the first to be analyzed using this computer system.

Project Manager: K.P. Ho
Proponent: HRS, UMD, RPD
Evaluator: UMD (D. Corkill); RPD
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K	$40K		$90K

7.113.1 Sensitivity of Bronchial Epithelial Cells to Alpha Radiation (86.8.2)

It is proposed to investigate the relative sensitivities of human bronchial epithelial cells to alpha radiation of energies of 8 MeV and below. This laboratory study will focus on the production of non-lethal chromosome aberrations in cells grown in a culture medium.

This study is proposed because the process of initiating lung cancer in humans by exposure to alpha radiation (such as is believed to occur in uranium mines) is not well understood. The cells of the bronchial epithelium which, upon absorption of alpha energy, initiate the development of lung cancer have not been identified with certainty.

It is anticipated that the findings of this study will provide information that is pertinent to understanding the mechanism of lung cancer induction by alpha radiation.

Project Manager: E. Rabin
Proponent: RPD, D. Brown (Sask. Dept. of Labour), HRS
Evaluator: RPD (C. Pomroy)
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$40K	$60K		$100K

7.114.1 Study of the Health Effects of Low-Level Exposure to Environmental Radiation in Port Hope (86.8.4)

By means of a literature review, interviews, and case control studies, it is proposed to: a) evaluate the health effects of low-level exposure to environmental radiation; measure the magnitude of risk of lung cancer induced by low-level alpha radiation; study the association between gamma radiation and leukemia; and b) determine the importance of environmental radiation in relation to the other major cancer risk factors and assist in the establishment of a relationship between radiation-induced cancer and radiation exposure.

This project is proposed because, in 1980, a case-control study of lung cancer among Port Hope residents turned out to be inconclusive. The earlier study was conducted in order to try to evaluate the relative importance of domestic radiation exposure due to radioactive contamination of homes from industrial sources. Based on 12 years of lung cancer incidence (1966-1977) and the information from radiation surveys, the study showed an elevated risk ratio in homes with elevated radon levels. However, because of the limited sample size, the association between lung cancer and radiation contamination did not reach a statistically significant level. Also, the design and analysis of the study have been criticized because of the small number of cancer cases, the questionable selection of controls, the effect of potential co-carcinogens which were not investigated, and the absence of investigations on leukemia. It is now possible to extend the 1980 study by utilizing 18 additional cases of lung cancer (compared to the original 27 in 1980 study) and by including all cases of leukemia. Controls will be selected and co-carcinogens investigated according to state-of-the-art techniques, and a new questionnaire will be compatible with that of the 1980 study, with additional questions on dietary habits. It is intended to include workers from Eldorado Resources Ltd. in the study.

It is anticipated that the results of the study will complement the Board's knowledge of the long-term effects of exposure to low-level alpha and gamma radiations, and will bring information on how the aging of an exposed population influences the results of epidemiological studies. The proposed study should also indicate how other parameters such as dietary habits, medical history and other non-radiological carcinogens influence the outcome of a case-control study on the health effects of radiation.

Project Manager: V. Elaguppillai
Proponent: Dept. of National Health & Welfare, HRS
Evaluator: RPD (C. Pomroy)
Contractor:
Category: 3c Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K	$50K		$110K

7.115.1 Study of the Recovery of Kidney Tissue from the Toxic Effects of Uranium (86.8.6)

It is proposed to conduct animal experiments with a view to re-evaluating the chemical toxicity of uranium. The study will concentrate on the extent and rate of recovery from tissue damage following nephrotoxic effects, and will help to select routine urine tests that will give good indications of kidney function.

There is evidence from animal experiments that observable kidney damage occurs at concentrations of uranium in tissue, as low as 1 microg/g,

although the present recommended maximum permissible limit is 3 microg/g. However, the links between histopathology and kidney function are uncertain, and although recovery of renal function has been observed, the rate and the extent of tissue recovery from damage caused by uranium are not well known, and no simple test exists yet that can be used to monitor the renal functions of uranium workers.

It is anticipated that the results of the study will increase the Board's knowledge of nephrotoxic effects associated with uranium intake, and will indicate the extent and rate of tissue recovery. The results derived from the routine urine tests are expected to indicate the feasibility and reliability of the monitoring of renal functions in uranium workers.

Project Manager: P.J. Duport
Proponent: HRS, RPD, D. Brown (Sask. Labour)
Evaluator: RPD (C. Pomroy)
Contractor:
Category: 3c Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K	$80K	$40K	$180K

7.116.1 Cancer Morbidity Follow-Up Feasibility Study Using the National Dose Registry of Canada (86.8.8)

It is proposed to determine the feasibility of using morbidity data sources available in Canada for individual medical follow-up studies by attempting to link the National Dose Registry with the Alberta Cancer Registry to determine any association between occupational radiation exposure levels and cancer incidence. This would be a first step toward potential future use of the National Cancer Data Base. It is further proposed to use a case-control methodology in which groups of individuals are selected based on whether or not they have the disease, in this instance, as collected by the Alberta Cancer Registry.

This feasibility study is proposed because morbidity data will greatly assist the AECB in determining whether any excessive health effects or risks exist due to exposure to certain potentially hazardous environmental, occupational or other factors. This information will both complement and supplement mortality data available through the Canadian Mortality Data Base by providing a more sensitive measure (than mortality data alone) of the differences in risk from exposure to potentially hazardous environmental, occupational or other factors and a possible earlier detection of any potential health hazard. It will allow for earlier preventive measures to be introduced in the workplace for current as well as future employees.

It is anticipated that this study will provide the AECB with: (i) the ability to draw upon more cancer data from Canadian sources; and (ii) the opportunity to detect the occurrence of any non-fatal or rare

cancers. In addition, it will assist the AECB in identifying areas of occupational, environmental, and other health risks for the general public, will aid the AECB in its regulatory activity and finally will help in providing information for the assessment of exposures and occupational hygiene practices.

Project Manager: K.P. Ho
Proponent: M. Smith (Statistics Canada), HRS
Evaluator: RPD
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$30K	$20K		$50K

7.117.1 Hospital Record-Keeping System for Case-Control Epidemiological Studies of Radiation-Induced Cancers (86.8.11)

It is proposed to conduct a feasibility study to modify hospital record-keeping systems to facilitate inexpensive case-control epidemiological studies of radiation-induced cancers.

Case-control studies of radiation-induced cancer can be conducted inexpensively using hospital records. However, the record-keeping systems in Canadian hospitals are not currently in a format to facilitate such studies.

It is anticipated that the results of the study will determine the feasibility of modifying hospital record-keeping systems to facilitate epidemiological studies. If the modification is feasible, several epidemiological studies of radiation-induced health effects can be conducted inexpensively to improve the corresponding risk estimates.

Project Manager: V. Elaguppillai
Proponent: RPD, HRS
Evaluator: RPD (C. Pomroy)
Contractor:
Category: 3c Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K			$50K

7.118.1 Selection of Control Groups for Use in Epidemiological Studies of Radiation-Induced Health Effects (86.8.12)

It is proposed to fund the development of a unified system of selecting control groups for use in epidemiological studies of radiation-induced health effects.

One of the major problems in interpreting the results of epidemiological studies of groups exposed to ionizing radiation is the general lack of comparability between different studies of similar groups. The main source of the problem is the variation of the quality of control groups used in the different studies. It is therefore essential to develop a comprehensive system or methodology for selecting control groups for use in Canadian epidemiological studies of radiation-induced health effects. Lack of uniformity in selecting control groups has also been recognized as a weakness in epidemiological studies in other countries.

It is anticipated that the results of the study will provide a unified system or methodology of selecting control groups for use in epidemiological studies of radiation-induced health effects.

Project Manager: V. Elaguppillai
Proponent: RPD, HRS
Evaluator: RPD
Contractor:
Category: 3b Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$45K			$45K

7.119.2 Full-Scale Epidemiological Study of Thyroid Cancer from I-131 Exposure (86.8.15)

It is proposed to continue funding the epidemiological study of thyroid cancer among Canadians who were exposed to radioactive iodines during diagnostic examinations.

This project is proposed because risk estimates for radiation-induced thyroid cancer are largely based on the incidence among those exposed to X-radiation. There is some controversy as to whether or not the same doses of I-131 and X-radiation are equally effective for the induction of thyroid cancer. A pilot study (84.8.13), jointly funded by the Alberta Cancer Board and the AECB, recommended a full-scale study at the national level to investigate the relative biological effectiveness of X-radiation and I-131.

The results of the study are expected to refine the risk estimates for radioiodine-induced thyroid cancers, and to determine whether or not equal (thyroid) doses of I-131 and X-radiation are equally effective in the induction of thyroid cancers. This is a joint study with nine provincial cancer registries and the Department of National Health &

Welfare which will contribute $271K to the project over the next two years.

Project Manager: V. Elaguppillai
Proponent: RPD, HRS
Evaluator: RPD (F. Horvath)
Contractor:
Category: 1 Review Panel: H2

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K	$50K	$50K	$150K

Earlier Directly Related Projects and Funding: 84.8.13
$61K $61K

7.120.1 Cytogenetic Measurements of the Relative Biological Effectiveness of Tritium (86.8.19)

It is proposed to measure the relative biological effectiveness of tritium (as compared to that of 200 kVp x-rays) for the induction of a) chromosomal aberrations in lymphocytes and b) reciprocal translocations in spermatogonia. The dose-response curves for each of the endpoints scored will be plotted and analyzed in a statistically rigorous manner. The experiments are to be carried out on the same strain of mouse, using the same irradiation facilities and protocols as those in Project 84.8.15 ("Measurement of RBE for Tritium for Induction of Myeloid Leukemia").

The radiological effects of tritium are of special concern to Canada because of the CANDU reactor technology which utilizes deuterium oxide as a moderator. As a consequence, tritium is formed and, inevitably, some atomic radiation workers are exposed to it. This tritium, usually in the form of tritiated water, becomes distributed throughout the body and incorporated into many molecules including lipids, proteins and DNA. Upon decay of the tritium, the beta particle may enter or arise in the cell's nucleus and cause chromosomal aberrations and gene mutations. If the beta particle from tritium originates in the DNA, the dose delivered to the nucleus that contains it is substantial because of the relatively low energy of the particle and its correspondingly short range. In this case, the dose distribution among nuclei at low doses will be very different from that of a corresponding average absorbed dose of x- or gamma-rays: a small number of nuclei will receive a dose much above the average while most of the other nuclei will be unexposed. Even at higher doses, the microdosimetry of the dose will be different from x- or gamma-rays as a result of different spectra of electron energies and, correspondingly, different spectra of linear energy transfers (LETs). Since LETs affect the biological effectiveness of radiations, the RBE of tritium may not be the same as 200 kVp x-rays, often taken as a standard. Accordingly, the careful evaluation of radiological risk from ionizing radiations conducted by various national and international

agencies cannot be applied directly to tritium exposure. For this reason, a study of the RBE of tritiated water for the induction of myeloid leukemia in mice is in progress (Project 84.8.15).

It is anticipated that the results of this study may enable AECB staff to quantify the risk of inducing myeloid leukemia based on cytological measurements, carried out long before the onset of this specific cancer. (Ontario Hydro is a co-contributor of a similar amount, namely $119K, for a project total of $238K.)

Project Manager: E. Rabin
Proponent: RPD, HRS
Evaluator: RPD (C. Pomroy)
Contractor: Bio-Mutatech, Inc.
Category: 1* Review Panel: H6

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$25K	$94K			$119K

7.121.1 Feasibility Study of Cancer Mortality among Patients Exposed to Ionizing Radiation during Cardiac Catheterization (87.8.5)

It is proposed to conduct a feasibility study of cancer mortality among nearly 3000 patients who were exposed to ionizing radiation during cardiac catheterization at the Hospital for Sick Children in Toronto during the period from 1946-1965.

There have been reports suggesting an excess in the incidence of leukemia, breast and thyroid cancers among those who received exposures as children to low doses of x-radiation during cardiac catheterization. No comprehensive epidemiological study has ever been undertaken to examine the relationship between the radiation exposures and the cancer mortality among those patients.

The results of this study will be used to determine the feasibility and the design of a full-scale study. Such a full-scale study will help to improve our understanding of the dose-response relationship received at low doses of ionizing radiation. This is a joint project with National Cancer Institute of Canada and Ontario Cancer Treatment and Research Foundation, which will contribute $65K to the project over the next two years.

Project Manager: V. Elaguppillai
Proponent: A. Clarke (OCTRF), RPD, HRS
Evaluator: RPD (F. Horvath)
Contractor:
Category: 3a Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$45K	$20K		$65K

7.122.1 Computerized Linkage of National Cancer Incidence Data with Cohorts in Radiation-Related Epidemiological Studies (87.8.6)

It is proposed to develop a satisfactory format for the computerized record linkage of national cancer incidence data with personal identifiers of breast and lung cancer patients who were previously exposed to fluoroscopic radiation during pneumothorax examination for tuberculosis.

The reason for proposing a cancer incidence linkage is to identify cancers which have occurred in the cohorts, but which have not been the underlying cause of death, and therefore have not been identified in the usual mortality linkage. This approach has never been used in any epidemiological studies of persons exposed to ionizing radiation.

The results of this study will help to determine whether the occurrence of a particular type of radiogenic cancer in any way yields a different mortality pattern for the same cancer, arising from a non-radiogenic cause. This study may have an impact on the risk estimates which form the basis of the dose limits for ionizing radiation. This is a joint project with National Cancer Institute of Canada and Statistics Canada, which will contribute $100K to the project over the next three years.

Project Manager: V. Elaguppillai
Proponent: National Cancer Institute of Canada (NCIC) - G. Howe, RPD, HRS
Evaluator: RPD
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$60K	$60K	$25K	$145K

7.123.1 DNA Repair and Variable Risk in Tumorigenesis (87.8.9)

It is proposed to study the alteration of DNA repair competence in mice following exposure to ionizing radiation and to heat. The target organ is to be skin, with skin tumors initiated by chemical carcinogens.

This study is proposed because earlier studies have shown that: a) a single exposure of skin to beta radiation prior to initiation with a chemical mutagen markedly reduced the risk of tumor formation; b) a single exposure of skin to heat prior to initiation with the same chemical mutagen markedly increased the risk of tumor formation; and c) multiple exposures of skin to heat during the promotion process markedly decreased the risk of tumor formation. These observations have relevance to workers in the nuclear industry who are likely to be under thermal stress at the same time they are exposed to ionizing radiation, as well as to workers who may be chronically exposed to beta radiation (e.g. workers who wear plastics at nuclear generating stations,

firefighters, such as those at Chernobyl, and numerous workers at the front end of the nuclear fuel cycle).

It is anticipated that the results of this study will allow AECB staff to a) define risk estimates of cancer formation by allowing for contributions to the risk associated with previous or subsequent exposures or which may be influenced by other environmental stresses in the workplace, and b) identify working conditions or procedures which may increase (or decrease) the hazard associated with exposure to ionizing radiation. (This study is to be jointly sponsored by AECL and AECB on a 50/50 cost shared basis.)

Project Manager: E. Rabin
Proponent: RPD
Evaluator: RPD (M.P. Measures)
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$80K	$32K		$112K

7.124.1 Superoxide Dismutase in White Blood Cells of Atomic Radiation Workers: An Epidemiological Study (87.8.10)

It is proposed to investigate the response to radiation exposure of human white blood cells in vivo. The response to radiation exposure to be studied is the change in the amount produced of superoxide dismutases and other anti-oxidant enzymes (such as glutathione peroxide).

This study is proposed because anti-oxidant enzymes are a first line of defense of cells against oxygen-containing free radicals of the type generated by ionizing radiation in living systems. These enzymes have been shown to be radioprotective. This work should provide further, more detailed, information on the universality of this defense mechanism in humans, and the variation of degree of response with age, sex and radiation dose occupationally received over defined time intervals prior to the times that the blood samples are withdrawn.

It is anticipated that this study will provide information on the different responses of population subgroups to ionizing radiation insult, i.e. help explain at the cellular and enzyme levels the reasons for displayed differences in radiosensitivity. (This study will also receive financial support from AECL. Ontario Hydro and Brookhaven National Laboratory in the U.S.A. are also prepared to cooperate in supplying blood donors from amongst their radiation workers. The AECL contribution is expected to be approximately $52,000 out of a total project cost of $232,000.)

Project Manager: E. Rabin
Proponent: RPD, HRS
Evaluator: RPD (C. Pomroy)
Contractor:
Category: 3b Review Panel: Planned

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$104K	$76K		$180K

7.125.1 Pilot Epidemiological Study of Genetic Disorders following Paternal Exposure to Ionizing Radiation and to Other Mutagens at the Work Place (87.8.11)

It is proposed to conduct a pilot epidemiological study of birth defects due to paternal exposure to ionizing radiation and to other mutagens present in the work place. Birth registration records containing information on father's occupation will be linked with birth defect records. The risk of birth defects will be analyzed as a function of exposure to radiation and to other physical agents at the work place.

The study is proposed because animal studies have indicated that genetic damage to germ cells by toxic agents such as ionizing radiation and other mutagens can lead to various abnormal pregnancy outcomes, including congenital malformations in offspring. It is therefore important to examine to what extent paternal radiation exposure contributes to birth defects in offspring and to derive a dose-effect relationship for genetically-induced birth defects. As a first step, a pilot study is proposed to examine the feasibility of a full-scale study.

It is anticipated that the results of the pilot study will demonstrate the feasibility of a full-scale study. If a full-scale study is feasible, the results of such a study will improve the risk estimates for radiation-induced genetic defects and enhance our understanding of the influences of paternal irradiation on hereditary defects. This is a joint project with B.C. Ministry of Health and Department of Medical Genetics of the University of British Columbia, U.S. March of Dimes, which will contribute $75K to the project over the next two years.

Project Manager: V. Elaguppillai
Proponent: RPD, HRS
Evaluator: RPD
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$43K	$40K		$83K

7.126.1 Promotion and Distribution of the Employee Identification Questionnaire and Its User Guide (87.8.12)

It is proposed to fund a project which is intended to promote the use of the employee identification questionnaire and the user guide developed and tested in the project entitled "Standardization of Individual Identifying Information for Health Record Keeping Methodology (85.8.16)". With information collected in Phase II (of 85.8.16) which will identify the potential users for this questionnaire, methods will be selected for advising Canadian companies and agencies, as well as international agencies and committees, with occupational health record keeping requirements, of the questionnaire with a view to encouraging its use.

This project is proposed, in particular, because the derived information is intended to be targeted at AECB licensees who are required to implement and maintain health record systems and who supply information on radiation doses to the National Dose Registry.

It is anticipated that the results of the study will facilitate and encourage adequate on-going individual record keeping for the preparation of current and past employee nominal rolls. In addition, it may form the basis of an unambiguous identification of the individual in conjunction with the collection of radiological and non-radiological exposure histories and work histories. These will allow for subsequent follow-up, by the AECB, of health outcomes (mortality, morbidity, and genetic effects) and will be of use for reporting purposes to registries (dose, exposure or disease), and for other legislative or regulatory requirements.

Project Manager: K.P. Ho
Proponent: M. Smith (Statistics Canada), HRS
Evaluator: RPD
Contractor:
Category: 3c

Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$25K			$25K

7.127.1 Dose Response of Human Lymphocytes to Radiation and Chemical Carcinogens (87.8.13)

It is proposed to investigate the feasibility of using a flow cytometry method for measuring radiation damage in fresh (recently extracted) human lymphocytes, and to measure the damage produced by a combined exposure to radiation, delivered at doses in the occupational range, and to chemical carcinogens.

This project is proposed because currently there is uncertainty as to whether radiation and chemical insults act synergistically, independently, or if the chemical carcinogens do not influence cell

response to radiation insult. This project is likely to be an appropriate follow-on to Project 85.8.15, "A Feasibility Study on the Identification and Determination of Exposure Levels of Non-Radiological Carcinogenic Substances at Canadian Nuclear Facilities", as it will provide experimental evidence of synergism or lack thereof.

It is anticipated that the findings of this study will assist AECB staff in quantifying the modifying influences of chemical carcinogens on the responses of workers to occupational radiation exposure.

Project Manager: K.P. Ho
Proponent: RPD, HRS
Evaluator: RPD
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$56K	$56K		$112K

7.128.1 Comparison of the Relative Impact of Radiation-Induced Serious Genetic Disorders among Canadians (87.8.15)

It is proposed to fund a study to determine the relative impact of different types of radiation-induced serious genetic disorders in terms of their respective loss of years of life expectancy by linking the B.C. Health Surveillance Registry Records with the Canadian National Mortality Data Base.

The study is proposed because the relative impact of different types of serious genetic disorders can only be compared on a common scale, such as in terms of their respective loss of years of life expectancy. To date, no comprehensive study has been done to derive the relationship between different types of genetic disorders and their respective loss of years of life expectancy in the Canadian context. The data base at the B.C. Health Surveillance Registry is considered to be a leading source in North America for such a complex analysis. Initiation of this study is awaiting the results of 85.8.18.

It is anticipated that the results of the study will enable the AECB to compare, on a common scale, the relative impact of different types of radiation-induced genetic disorders. (A joint study with B.C. Ministry of Health and Statistics Canada.)

Project Manager: V. Elaguppillai
Proponent: S. Sheps (UBC), M. Smith (StatsCan), RPD, HRS
Evaluator: RPD
Contractor:
Category: 3c Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$45K	$45K		$90K

8. Transportation

8.101.1 Doses to Road Transport Workers from Radioactive Materials (86.7.1)

It is proposed to measure, over a defined period of time, the doses received by a selected subpopulation of road transport workers. The measurements are to be correlated with the type of radioactive material present in the appropriate shipments. Dose estimates are to be based on personal dosimetry measurements wherever possible; otherwise, the calculated doses will be based on realistic exposure models.

This work is proposed because there are indications that some road transport workers may be receiving exposures which would require their classification as Atomic Radiation Workers. Other incidents point to a need for a comprehensive assessment of the exposures received by road transport workers whose employers are not AECB licensees.

It is anticipated that this work will result in the identification of problem areas (with respect to radioactive materials) in the road transportation industry and in improvements in the compliance and regulatory system. It will also contribute to the IAEA database on risk assessment with respect to road transport workers. (The project is to be funded by Transport Canada, administered by the Atomic Energy Control Board, and supplied with dosimetry services by the Department of National Health and Welfare. The project cost will be approximately $85K.)

Project Manager: E. Rabin
Proponent: RTD, Transport Canada
Evaluator: RTD (G.B. Johnston)
Contractor: MacLaren Engineers
Category: 1* Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total

9. Regulations & Regulatory Process Development

9.101.1 Socio-Economic Impact Analysis of Proposed General Amendments to Atomic Energy Control Regulations (85.9.2)

It is proposed to investigate the socio-economic impact of the intended General Amendments to the Atomic Energy Control Regulations. The incremental costs and benefits of these regulations to the Canadian nuclear industry and other users of radioactive materials as well as to Canadian society in general will be predicted and subjected to cost-benefit or related analysis.

This work is being proposed in accordance with Treasury Board's previous requirements concerning new major health, safety and fairness regulations. It is being continued under the government's policy on the need for a Regulatory Impact Analysis Statement (RIAS). It is not yet known whether these amendments will have a "major" impact as defined in Chapter 490 of Treasury Board's Administrative Policy Manual, and hence the need for a socio-economic impact analysis has not yet been confirmed. However, the AECB anticipates that the level of public concern likely to be produced by these amendments will justify the performance of such an analysis. The AECB must determine whether any part of the proposed amendments to the regulations would pose unjustified costs and whether these amendments are the most effective means of meeting the objectives of health, safety, and environmental protection.

It is anticipated that the results of this study will aid the AECB in its review of the proposed amendments. In addition, this study is expected to be used to satisfy government requirements under its new Regulatory Reform Strategy.

Project Manager: C. St-Arneault
Proponent: Senior Review Group
Evaluator: Senior Review Group
Contractor: Econosult Inc.
Category: 1* Review Panel: H9

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
	$90K	$52K			$142K

9.102.1 Review of Crisis Management Methods (86.9.3)

It is proposed to continue a review of AECB operations and corporate planning and, based on the latest developments in crisis management, to determine which elements of crisis management should be included in corporate planning, and in the preparation of a crisis management manual.

Although there are AECB documents that deal with emergency response at the working level (e.g., duty officer's handbook, divisional operating procedures), there is no corporate document that deals with broader questions such as: - the establishment of a crisis team; - communications with the public, who handles it, and how? - chain of command in the absence of someone in the management structure; - interaction with other government agencies; - role of the AECB Emergency Response Coordinator.

The results of this review will assist AECB staff in updating corporate planning to address crisis management, and in preparing a detailed crisis management manual.

Project Manager: D.E. Connelly
Proponent: DFC
Evaluator: DFC (W.D. Smythe); PCS (T. Diamantstein)
Contractor:
Category: 3a Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$25K			$25K

9.103.1 Study of the AECB Long Range Plan for Information Management (87.9.2)

It is proposed to determine the technical feasibility and to design and prepare a plan for its implementation for the period March 1989 to 1993 of the AECB's strategy for document management, outlined in AECB "Strategic Plan for Information Management 1986-1991". Factors that will be taken into account for the technical feasibility and practicality of the "Strategic Plan for Information Management" include current and projected technologies, worker acceptance of the new technologies, legal issues and interface with external information providers to the AECB.

This work is proposed because the AECB's long-term objectives for information management, particularly for the management of documents, represent a very significant departure from traditional practices. A detailed study of the technical feasibility and practicality of the "Strategic Plan for Information Management" must be established prior to the proposed implementation of the plan projected to take place during fiscal years 1989 to 1993.

The results of this project will enable the AECB to confirm the direction it will be taking on information management and to implement the long-range plan for information management.

Project Manager: D.E. Connelly
Proponent: IMS
Evaluator: ADD (J.G. Waddington); IMS (W.D. Goodwin)
Contractor:
Category: 1 Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$75K	$75K		$150K

9.104.1 Regulatory Effectiveness Measurement System (87.9.3)

It is proposed to investigate the feasibility of a Regulatory Effectiveness Measurement System (REMS) to determine what has to be measured in order to show how effective the AECB is in carrying out its regulatory mandate. This is to be achieved by defining what information (in general terms) is needed as an input to the AECB decision-making process to produce a comprehensive data model and by defining the outputs of the model that would be used to evaluate the preferred process for decision-making. In addition, a prototype system for a typical area of interest (e.g., impact of the AECB program on the nuclear industry's safety record) is to be included as part of the scope of the study.

This study is being proposed recognizing the Government's initiatives to downsize the Public Service and to improve the management of regulatory programs, such as that of the AECB which costs approximately $23 million annually. The Government's initiatives will require increased efforts by the AECB to improve its productivity and ensure effectiveness of its activities. At the moment, for example, there is little evidence to correlate the safety record of the nuclear industry to AECB activities.

It is anticipated that the results of this project will demonstrate the feasibility of a high level management information system which could provide AECB senior management with an early warning system for potential problems and help to ensure the effective use of resources.

Project Manager: C. St-Arneault
Proponent: ADD
Evaluator: ADD (J.G. Waddington); IMS (W. Goodwin)
Contractor:
Category: 3b Review Panel: No

Past	FY 86/87	FY 87/88	FY 88/89	Future	Total
		$50K	$100K		$150K

SUMMARY ANALYSIS OF AECB R & D BUDGET

BY MISSION OBJECT

(FY 87/88 BUDGET ALLOCATION: $2,450,000)

MISSION OBJECT	FY 87/88 BUDGET ALLOCATION (K$)				
	CATEGORIES 1* & 1 & 2	CATEGORY 3A	CATEGORY 3B	CATEGORY 3C	TOTAL
2. NUCLEAR REACTORS	642	160	95	130	1,027
3. OTHER FUEL CYCLE FACILITIES, GENERAL	351	100	195	20	666
4. URANIUM MINES AND MILLS	590	-	110	130	830
5. WASTE MANAGEMENT	249	155	-	30	434
6. NON FUEL CYCLE APPLICATIONS	19	25	50	-	94
7. HEALTH PHYSICS	613	138	565	240	1,556
8. TRANSPORTATION	-	-	-	-	-
9. REGULATIONS & REGULATORY PROCESS DEVELOPMENT	127	25	50	-	202
TOTALS	2,591	603	1,065	550	4,809

EXPLANATION OF PROJECT SUMMARIES
(see project 2.105.1 for a complete example)

A. Project Number (unique to project)

- first digit: number of the Mission Object (see main headings in list);
  2. Nuclear Reactors to
  9. Regulations and Regulatory Process Development
- second set of digits: item number (beginning with number 101) within the Mission Object
- third digit: contract or phase number in a sequence of related contracts for a given item number (e.g., a full-scale study (2) following a feasibility study (1)). The number 1 appears even if a project is not subdivided into phases.

B. Title:

C. Previous Project Number:
The project number used in previous program descriptions is given in parenthesis.

D. Summary:
The three paragraphs state:

- WHAT is proposed or in progress and by what means
- WHY this project is proposed (the justification)
- HOW it is intended to use the results.

The participation, if any, of other organizations is also mentioned.

E. Project Manager (P.M.):
Name of staff member within the Regulatory Research Branch responsible for the project (to the extent that the AECB is committed, in the case of joint projects).

F. Proponent:
Originating division within the AECB, or other originator, of the proposal. (Abbreviations refer to AECB organizational units, whose full names are given on the following pages.)

G. Evaluation:
AECB division (and individual staff member, where known) which gives advice to, or for liaison with, the Project Manager on certain technical aspects of the project. The evaluator assesses the quality of the work done by the contractor and also assesses how the results of the project may be used by the AECB, through a post-project evaluation.

H. Contractor:
For projects in progress; the name of the company, or institution doing the work. If known, the name of the principal investigator is given.

I. Category:
(1) - Projects intended to be initiated in the program year.
(1*) - Projects in progress at the beginning of the program year.
(2) - Projects which would be category 1 but depend on the outcome of other work, e.g., on the results of a feasibility study.
(3a, 3b, 3c) - Projects deferred to next or subsequent years or held in reserve in the event that funds become available in the program year. (The letters a, b and c indicate successively lower priority projects).

J. Review Panel:
The Review Panel is a group of internal and external experts set up by the AECB to give advice to the Project Manager on some or all technical aspects of the project. A panel is automatically included in the post-project evaluation, even if not so shown in block G. If a panel is intended but not yet formed the word "planned" appears.

K. Funding:

Previous Years:	Year Prior to Program Year:	Program Year:	Year After Program Year:	Subsequent Years:	Project Total

- Actual expenditures are shown for past years.
- Budgeted amount is shown for the program year; but this amount is subject to change. For Category 2 and 3 items the amount may be quite speculative.
- Amounts shown for years after the program year can be very speculative.

L. Related Projects:
Earlier directly related projects are shown by project number along with the previous expenditures, by year, on such projects. Directly related projects may be literature reviews, feasibility or pilot studies, or earlier phases of a project consisting of more than one contract in series.

LIST OF REVIEW PANELS FOR R&D PROJECTS

H1 RADIATION-INDUCED DEVELOPMENTAL DEFECTS

Project Manager: V. Elaguppillai

Panel Members

- Professor L.E. Becker
  University of Toronto, Toronto, Ontario
- Professor W.J. Schull
  The University of Texas Health Sciences Centre, Houston, Texas
- Dr. Jan Muller
  Willowdale, Ontario
- Professor P. Rakic
  Yale University, New Haven, Connecticut
- Professor T.V.N. Persaud
  University of Manitoba, Winnipeg, Manitoba
- Dr. D.K. Myers
  Atomic Energy of Canada Limited, Chalk River, Ontario

In Progress: Epidemiological Study of Radiation-Induced Developmental Defects (7.105.1)

Planned: In-Vitro Study of the Effects of Ionizing Radiation on the Developing Central Nervous System (7.111.1)

H2 EPIDEMIOLOGY

Project Manager: V. Elaguppillai

Panel Members

- Dr. S. Buehler
  The General Hospital, St. John's, Newfoundland
- Dr. D.H. Thomson
  Cancer Treatment and Research Foundation
  of Nova Scotia, Halifax, Nova Scotia
- Dr. N. Kreiger
  The Ontario Cancer Treatment and Research Foundation
  Toronto, Ontario
- Ms. D. Robson
  Saskatchewan Cancer Foundation, Regina, Saskatchewan
- Dr. G. Theriault
  McGill University, Montreal, Quebec
- Ms. M. McBride
  Cancer Control Agency of B.C., Vancouver, British Columbia
- Dr. J.C. Wallace
  Saint John General Hospital, Saint John, New Brunswick

- Dr. G.B. Hill
  Alberta Cancer Board, Edmonton, Alberta
- Dr. L. Marrett
  The Ontario Cancer Treatment and Research Foundation
  Toronto, Ontario

In Progress: Epidemiological Study of Thyroid Cancer from I-131 Exposure (7.119.2)

H3 INHALATION STUDIES

Project Manager: P.J. Duport

Panel Members

- Dr. D.H. Bowden
  University of Manitoba, Winnipeg, Manitoba
- Dr. L.D. Brown
  Saskatchewan Department of Labour, Regina, Saskatchewan
- Dr. J. Chameaud
  COGEMA, Razes, France
- Dr. V. Elaguppillai
  Atomic Energy Control Board, Ottawa, Ontario
- Mr. F. Horvath
  Atomic Energy Control Board, Ottawa, Ontario
- Dr. A.C. James
  National Radiological Protection Board, Chilton, United Kingdom
- Dr. J. Lafuma
  Centre d'Études Nucléaires de Fontenay-aux-Roses,
  Fonetenay-aux-Roses, France
- Dr. Y. Mao
  Health and Welfare Canada, Ottawa, Ontario
- Dr. R. Masse
  Centre d'Études Nucléaires de Fontenay-aux-Roses,
  Fontenay-aux-Roses, France
- Dr. J. Muller
  Ontario Ministry of Labour, Toronto, Ontario
- Mr. C. Pomroy
  Atomic Energy Control Board, Ottawa, Ontario
- Dr. B.L. Tracy
  Health and Welfare Canada, Ottawa, Ontario
- Dr. M. Wrenn
  University of Utah, Salt Lake City, Utah

In Progress: Study of the Health Effects of Inhaled Uranium Ore Dust (3.101.1)

H4 DOSIMETRIC MODELS

Project Manager: P.J. Duport

Planned: Compilation and Critical Evaluation of Data used to Derive Current Dosimetric Models for Uranium (5.111.1)

H5 LUNG SOLUBILITY STUDIES

Project Manager: K.P. Ho

Panel Members

- Mr. J. Tai-Pow
  Ontario Ministry of Labour, Toronto, Ontario
- Dr. M.L. Zamora
  BRMD, Health and Welfare Canada, Ottawa, Ontario
- Dr. J.R. Johnson
  Atomic Energy of Canada Limited, Chalk River, Ontario
- Mr. F. Horvath
  Atomic Energy Control Board, Ottawa, Ontario

In Progress: Physical Characteristics and Solubility of Airborne Long-Lived Dust in Uranium Producing and Manufacturing Facilities (3.103.2)

H6 RELATIVE BIOLOGICAL EFFECTIVENESS (RBE)

Project Manager: E. Rabin

Panel Members

- Dr. D. Whillans
  Ontario Hydro, Pickering, Ontario
- Dr. K.Y. Wong
  Canadian Fusion Fuels Technology Project, Mississauga, Ontario
- Mr. J. Baltar
  Hydro Quebec, Comté de Nicolet, Quebec
- Mr. C. Pomroy
  Atomic Energy Control Board, Ottawa, Ontario
- Mr. J. Burnham
  New Brunswick Electric Power Commission, Fredericton, New Brunswick
- Dr. A.L. Carsten
  Brookhaven National Laboratory, Long Island, New York

In Progress: Measurement of RBE for Tritium for Myeloid Leukemia (7.103.2)

H6.1 = H6 + Dr. G.R. Douglas
Health and Welfare Canada, Ottawa, Ontario

In Progress: Cytogenetic Measurements of the Relative Biological Effectiveness for Tritium (7.120.1)

H7 BRONCHIAL EPITHELIUM

Project Manager: E. Rabin

Panel Members

- Mr. C. Pomroy
  Atomic Energy Control Board, Ottawa, Ontario
- Dr. B. Case
  Royal Victoria Hospital, Montreal, Quebec
- Dr. I. Dardick
  Ottawa Civic Hospital, Ottawa, Ontario
- Dr. J.R. Johnson/Dr. D.K. Myers
  Atomic Energy of Canada Limited, Chalk River, Ontario
- Dr. R. Narbaitz
  University of Ottawa, Ottawa, Ontario

In Progress: Measurement of the Thickness of Bronchial Epithelium (7.102.1)

H8 RADIOSENSITIVITY OF BIOLOGICAL SYSTEMS

Project Manager: E. Rabin

Panel Members

- Dr. O. Kamra
  Dalhousie University, Halifax, Nova Scotia
- Dr. S. Raman
  University of Ottawa, Ottawa, Ontario
- Dr. M. Paterson
  Cross Cancer Institute, Edmonton, Alberta
- Dr. M.W. McBurney
  University of Ottawa, Ottawa, Ontario

In Progress: Screening of Human Populations for Abnormal Radiosensitivity (7.110.1)

H9 REGULATORY IMPACT ANALYSIS

Project Manager: C. St-Arneault

Panel Members

Senior Review Group, Atomic Energy Control Board
- Mr. J.H. Jennekens
- Mr. P.E. Hamel
- Mr. J.W. Beare
- Mr. Z. Domaratzki
- Mr. R.W. Blackburn
- Mr. W.D. Smythe

- Mr. P. Barker
- Mr. D. Bird
- Mr. A. Ross

In Progress: Socio-Economic Impact Analysis of the Proposed General Amendments to Atomic Energy Control Regulations (9.101.1)

S1 HYDROGEOLOGY

Project Manager: J.L. Wallach

Panel Member

- Dr. M. Sklash
  University of Windsor, Windsor, Ontario

In Progress: State-of-Stress and Groundwater Flow (4.104.1)

S2 GEOLOGY

Project Manager: J.L. Wallach

Planned: Neotectonic Conditions in Eastern Canada - Phase I (5.104.1)

S2.1 Panel Member

Dr. H. Helmstaedt
Queen's University, Kingston, Ontario

In Progress: Stress Measurements in Eastern Ontario - Phase 4 (5.110.4)

S2.2 Panel Member

Dr. H. Schwarcz
McMaster University, Hamilton, Ontario

In Progress: Demonstration of the Feasibility of Directly Dating Quartz (5.101.1)

S2.3 Panel Member

Mr. D.A. Forsyth
Geological Survey of Canada, Ottawa, Ontario

In Progress: Geological Evidence of Seismicity - Charlevoix (5.102.1)

S2.4 Panel Member

Dr. M. Sklash
University of Windsor, Windsor, Ontario

In Progress: State-of-Stress and Groundwater Flow (4.104.1)

S3 ENVIRONMENTAL PATHWAYS

Project Manager: M.R. Avadhanula

Panel Members

- Mr. J. Tai-Pow
  Ontario Ministry of Labour, Toronto, Ontario
- Dr. P. Colgan
  Queen's University, Kingston, Ontario
- Dr. R.M. Chatterjee
  Atomic Energy Control Board, Ottawa, Ontario

In Progress: Transfer Parameters - Non-Domesticated Animals (5.105.1)

Planned: Effect of Soil Type on Radionuclides in Plants: Field Study (5.109.2)

Remeasurement of Th-230 in the Pore Water of Lacnor Tailings (4.112.1)

S3.1 = S3 + Mr. J. Mes
Health and Welfare Canada, Ottawa, Ontario
Dr. D. Kinloch
Health and Welfare Canada, Yellowknife, Northwest Territories

In Progress: Transfer of Radionuclides to Human Milk - Phase 2 (5.106.2)

S4 SOFTWARE RELIABILITY

Project Manager: D.E. Connelly

Panel Members:

- Dr. E.A. Sudicky
  University of Waterloo, Waterloo, Ontario
- Dr. J.W. Chinneck
  Carleton University, Ottawa, Ontario

In Progress: Verification, Validation and QA for Waste Disposal Models (4.101.1)

Planned: Survey of Software Configuration Control Methods (2.109.1)

Documentation of Real-Time Power Reactor Software (2.117.1)

A Review of the Validation of Environmental Models (5.108.1)

S5 OFF-SITE DOSE

Project Manager: D.J. Martin

Panel Members:

- Mr. G. Gunter
  New Brunswick Electric Power Commission, Fredericton, New Brunswick
- Mr. K.J. Donnelly
  Ontario Hydro, Toronto, Ontario
- Mr. A. Natalizio
  Atomic Energy of Canada Limited, Mississauga, Ontario
- Mr. P. Finlay
  Environment Canada, Ottawa, Ontario
- Dr. M. Bewers
  Beford Institue of Oceanography, Halifax, Nova Scotia
- Mr. W.R. Bush/Dr. R.M. Chatterjee
  Atomic Energy Control Board, Ottawa, Ontario

In Progress: Cost-Effectiveness of Alternate Effluent Control Technologies (2.124.1)

NEW NUMBER CODES AND TITLES

2.101.1	Instrument Behaviour under Off-Normal Conditions (84.1.6)
2.102.1	A Tool to Analyze Real-Time Programs (84.1.20)
2.103.1	Aerosols and Fission Product Transport (85.1.4)
2.104.1	The Use of Full-Scope Simulators in Training and Qualification (85.1.7)
2.105.1	Crack Propagation in Tough Ductile Materials (85.1.8)
2.106.1	Selection of Equipment for Equipment Qualification (86.1.1)
2.107.1	Technical Basis for Equipment Qualification Assessments (86.1.2)
2.108.1	Survey of NPP Environments for Equipment Qualification (86.1.3)
2.109.1	Survey of Software Configuration Control Methods (86.1.14)
2.110.1	Plant Air Quality following Accidental Radioactive Releases (86.1.15)
2.111.1	International Piping Integrity Research Group (86.1.18)
2.112.1	Microcomputer Software for Heat Transfer Prediction (86.1.19)
2.113.1	Aging of Elastomers in CANDU Pressure Boundary Service (86.1.20)
2.114.2	A Simulator for Evaluating Emergency Operating Procedures (86.1.21)
2.115.1	Aging and Malfunction of Valves in CANDU Applications (87.1.1)
2.116.1	Failure Modes of Programmable Controllers and Microprocessors (87.1.2)
2.117.1	Documentation of Real-Time Power Reactor Software (87.1.3)
2.118.1	Behaviour of the Calandria Structure under Severe Conditions (87.1.4)
2.119.2	Updating of the DARSIM Simulation Program (87.1.5)

2.119.3	Conversion of DARSIM to Run on an Apollo Computer (87.1.10)
2.120.1	Models for Molten Fuel/Moderator Interaction (87.1.6)
2.121.1	Study of the Dissemination of Fission Products around Undamaged Spent Fuel Bundles (87.1.7)
2.122.1	Non-Uniformity of Hydrogen in Fuelling Machine Vaults (87.1.8)
2.123.1	Effect of Geometry on Hydrogen Burn in Calandria (87.1.9)
2.124.1	Cost-Effectiveness of Reduction of Off-Site Dose (85.8.11)
2.125.1	Measurement of Carbon-14 in Food and in the Excretions of Canadians (87.8.4)
3.101.1	Demonstration of the Feasibility of Directly Dating Quartz (84.4.1)
3.102.1	Geological Evidence of Seismicity - Charlevoix (85.4.10)
3.103.1	Measurement of Absorbed Fraction of Ingested Uranium in Humans (85.8.12)
3.104.1	Neotectonic Conditions in Eastern Canada - Phase I (86.4.2)
3.105.1	Transfer Parameters - Non-Domesticated Animals (86.4.5)
3.106.2	Transfer of Radionuclides to Human Milk - Phase 2 Feasibility (86.4.9)
3.106.3	Transfer of Radionuclides to Human Milk - Phase 3 Field Study (87.4.7)
3.107.1	Stresses to Induce Failure across Faults and Fractures (87.4.1)
3.108.1	A Review of the Validation of Environmental Models (87.4.2)
3.109.2	Effect of Soil Type on Radionuclides in Plants: Field Study (87.4.4)
3.110.4	Stress Measurements in Eastern Ontario - Phase 4 (87.4.5)
3.111.1	Compilation and Critical Evaluation of Data Used to Derive Current Dosimetric Models for Uranium (87.8.1)

3.112.1	Study of Kidney Functions in Uranium Workers (87.8.2)
3.113.1	Calculation of Derived Release Limits on a Personal Computer (87.8.3)
3.114.1	Clinical Emergency Response to Accidents Involving Radiation Contamination to Individuals (87.8.7)
3.115.1	Suitability of Neutron Dosimeters and Survey Meters in Various Field Conditions - Phase I (87.8.8)
3.115.2	Suitability of Neutron Dosimeters and Survey Meters in Various Field Conditions - Phase II (87.8.14)
3.116.1	Radiation Sensitivity of Organisms Other than Man: A Review (87.8.16)
4.101.1	Study of the Health Effects of Inhaled Uranium Ore Dust (84.8.11)
4.102.1	Comparison of the Techniques Used in Estimating Past Exposures to Radon Daughters in Canadian Mines (85.8.8)
4.103.2	Physical Characteristics and Solubility of Long-Lived Airborne Particulates in Uranium Producing and Manufacturing Facilities (85.3.6)
4.104.1	Determination of Radon and Thoron Fluxes in Uranium Mines (Ontario) (85.3.10)
4.105.1	Determination of Radon Fluxes in Uranium Mines (Saskatchewan) (85.3.11)
4.106.2	Ontario Miners Mortality Study - Update (86.8.18)
4.107.1	Development of a Radiation Safety Training Module for Use in Canadian Uranium and Thorium Mines (86.9.2)
4.108.1	Intercomparison of Instruments Used in the Determination of Size Distribution of Airborne Particles in Canadian Uranium Mines and Mills (86.3.1)
4.109.1	Calibration of Wire Screen Collectors Used in the Measurement of Unattached Fraction of Radon and Thoron Progeny in Air (86.3.2)
4.110.1	Modified Personal Alpha Dosimeter for Canadian Uranium Mines (86.3.5)
4.111.1	Uranium Mine Radiation Safety Course (87.9.1)
4.112.1	Determination of the Electrical Charge of Radioactive Aerosols in Uranium Mines (87.3.1)

4.113.1	Tracer Gas Method for Assessing Ventilation Efficiency in Underground Uranium Mines and in Mills (87.3.2)
4.114.1	Dust Removal from Uranium Mine Atmospheres by Means of Electrically Charged Water Spray (87.3.3)
5.101.1	Verification and Validation for Waste Disposal Models (85.5.8)
5.102.1	Optimization in the Decommissioning of Uranium Tailings (85.5.9)
5.103.2	Waste Management Implications of Concentrating Slimes - II (86.5.1)
5.104.1	State-of-Stress and Groundwater Flow (86.5.2)
5.105.1	Performance of Engineered Barriers for Low-Level Wastes (86.5.3)
5.106.1	Methodology for Estimating Probabilities of Intrusion (86.5.4)
5.107.1	Erosion of Surface and Near-Surface Disposal Facilities (86.5.7)
5.108.2	Plotting for a Groundwater Flow/Contaminant Transport Model (86.5.8)
5.109.1	Sensitivity Study of the Concept of Deep Geologic Disposal (86.5.9)
5.109.2	Analysis of the Concept of Deep Geologic Disposal (87.5.7)
5.110.2	Measurement of Thorium Concentration in Fish: A Field Study (87.4.3)
5.111.1	Effective Communication with the General Public (87.4.6)
5.112.1	Remeasurement of Th-230 in the Pore Water of Lacnor Tailings (87.5.1)
5.113.1	Non-Radioactive Contaminants in Uranium Raffinates (87.5.2)
5.114.1	Installation of SYVAC III on AECB Computer (87.5.3)
5.115.1	Software Quality Assurance for Waste Disposal Models (87.5.4)
5.116.1	Development and Administration of UTAP Training Workshop (87.5.5)

5.117.1	Summary of Results from the National Uranium Tailings Program (87.5.6)
6.101.1	Doses from Portable Gauges (86.6.2)
6.102.1	Radiation Doses to Technologists from Radiotherapy Treatment Procedures (86.6.4)
6.103.1	Feasibility of Using Beta-Gamma Counting of Ra-228/Ac-228 in Urinalysis (87.6.1)
6.104.1	Production of a Hospital Radiation Safety Officer's Handbook (87.6.2)
7.101.1	The Canadian National Dose Registry Study (84.8.10)
7.102.1	Measurement of the Thickness of Bronchial Epithelium (84.8.14)
7.103.2	Measurement of RBE for Tritium for Myeloid Leukemia (84.8.15)
7.104.1	Revision of Name-Encoding Scheme (NYSIIS) for Use by Canadian Epidemiological Studies (85.8.6)
7.105.1	Epidemiological Study of Radiation-Induced Developmental Defects among Canadians (85.8.7)
7.106.2	Full-Scale Study of Health Effects on Central Nervous System following In Utero Exposure (85.8.13)
7.107.1	A Feasibility Study on the Identification and Determination of Exposure Levels of Non-Radiological Carcinogenic Substances at Canadian Nuclear Facilities (85.8.15)
7.108.1	Standardization of Individual Identifying Information for Health Record Keeping Methodology (85.8.16)
7.109.1	Epidemiological Study of Genetic Disorders in Adults (85.8.18)
7.110.1	Screening of Human Populations for Abnormal Radiosensitivity (85.8.20)
7.111.1	In Vitro and In Vivo Studies of the Effects of Ionizing Radiation on the Developing Central Nervous System (85.8.22)
7.112.1	Development of a Dosimetry Database for Atomic Radiation Workers in Canada (86.3.3)
7.113.1	Sensitivity of Bronchial Epithelial Cells to Alpha Radiation (86.8.2)

7.114.1	Study of the Health Effects of Low-Level Exposure to Environmental Radiation in Port Hope (86.8.4)
7.115.1	Study of the Recovery of Kidney Tissue from the Toxic Effects of Uranium (86.8.6)
7.116.1	Cancer Morbidity Follow-Up Feasibility Study Using the National Dose Registry of Canada (86.8.8)
7.117.1	Hospital Record-Keeping System for Case-Control Epidemiological Studies of Radiation-Induced Cancers (86.8.11)
7.118.1	Selection of Control Groups for Use in Epidemiological Studies of Radiation-Induced Health Effects (86.8.12)
7.119.2	Full-Scale Epidemiological Study of Thyroid Cancer from I-131 Exposure (86.8.15)
7.120.1	Cytogenetic Measurements of the Relative Biological Effectiveness of Tritium (86.8.19)
7.121.1	Feasibility Study of Cancer Mortality among Patients Exposed to Ionizing Radiation during Cardiac Catheterization (87.8.5)
7.122.1	Computerized Linkage of National Cancer Incidence Data with Cohorts in Radiation-Related Epidemiological Studies (87.8.6)
7.123.1	DNA Repair and Variable Risk in Tumorigenesis (87.8.9)
7.124.1	Superoxide Dismutase in White Blood Cells of Atomic Radiation Workers: An Epidemiological Study (87.8.10)
7.125.1	Pilot Epidemiological Study of Genetic Disorders following Paternal Exposure to Ionizing Radiation and to Other Mutagens at the Work Place (87.8.11)
7.126.1	Promotion and Distribution of the Employee Identification Questionnaire and Its User Guide (87.8.12)
7.127.1	Dose Response of Human Lymphocytes to Radiation and Chemical Carcinogens (87.8.13)
7.128.1	Comparison of the Relative Impact of Radiation-Induced Serious Genetic Disorders among Canadians (87.8.15)
8.101.1	Doses to Road Transport Workers from Radioactive Materials (86.7.1)

9.101.1	Socio-Economic Impact Analysis of Proposed General Amendments to Atomic Energy Control Regulations (85.9.2)
9.102.1	Review of Crisis Management Methods (86.9.3)
9.103.1	Study of the AECB Long Range Plan for Information Management (87.9.2)
9.104.1	Regulatory Effectiveness Measurement System (87.9.3)

OLD NUMBER CODES AND TITLES

84.1.6 Instrument Behaviour under Off-Normal Conditions (2.101.1)

84.1.20 A Tool to Analyze Real-Time Programs (2.102.1)

85.1.4 Aerosols and Fission Product Transport (2.103.1)

85.1.7 The Use of Full-Scope Simulators in Training and Qualification (2.104.1)

85.1.8 Crack Propagation in Tough Ductile Materials (2.105.1)

86.1.1 Selection of Equipment for Equipment Qualification (2.106.1)

86.1.2 Technical Basis for Equipment Qualification Assessments (2.107.1)

86.1.3 Survey of NPP Environments for Equipment Qualification (2.108.1)

86.1.14 Survey of Software Configuration Control Methods (2.109.1)

86.1.15 Plant Air Quality following Accidental Radioactive Releases (2.110.1)

86.1.18 International Piping Integrity Research Group (2.111.1)

86.1.19 Microcomputer Software for Heat Transfer Prediction (2.112.1)

86.1.20 Aging of Elastomers in CANDU Pressure Boundary Service (2.113.1)

86.1.21 A Simulator for Evaluating Emergency Operating Procedures (2.114.2)

87.1.1 Aging and Malfunction of Valves in CANDU Applications (2.115.1)

87.1.2 Failure Modes of Programmable Controllers and Microprocessors (2.116.1)

87.1.3 Documentation of Real-Time Power Reactor Software (2.117.1)

87.1.4 Behaviour of the Calandria Structure under Severe Conditions (2.118.1)

87.1.5 Updating of the DARSIM Simulation Program (2.119.2)

87.1.6 Models for Molten Fuel/Moderator Interaction (2.120.1)

87.1.7 Study of the Dissemination of Fission Products around Undamaged Spent Fuel Bundles (2.121.1)

87.1.8 Non-Uniformity of Hydrogen in Fuelling Machine Vaults (2.122.1)

87.1.9 Effect of Geometry on Hydrogen Burn in Calandria (2.123.1)

87.1.10 Conversion of DARSIM to Run on an Apollo Computer (2.119.3)

85.3.6 Physical Characteristics and Solubility of Long-Lived Airborne Particulates in Uranium Producing and Manufacturing Facilities (4.103.2)

85.3.10 Determination of Radon and Thoron Fluxes in Uranium Mines (Ontario) (4.104.1)

85.3.11 Determination of Radon Fluxes in Uranium Mines (Saskatchewan) (4.105.1)

86.3.1 Intercomparison of Instruments Used in the Determination of Size Distribution of Airborne Particles in Canadian Uranium Mines and Mills (4.108.1)

86.3.2 Calibration of Wire Screen Collectors Used in the Measurement of Unattached Fraction of Radon and Thoron Progeny in Air (4.109.1)

86.3.3 Development of a Dosimetry Database for Atomic Radiation Workers in Canada (7.112.1)

86.3.5 Modified Personal Alpha Dosimeter for Canadian Uranium Mines (4.110.1)

87.3.1 Determination of the Electrical Charge of Radioactive Aerosols in Uranium Mines (4.112.1)

87.3.2 Tracer Gas Method for Assessing Ventilation Efficiency in Underground Uranium Mines and in Mills (4.113.1)

87.3.3 Dust Removal from Uranium Mine Atmospheres by Means of Electrically Charged Water Spray (4.114.1)

84.4.1 Demonstration of the Feasibility of Directly Dating Quartz (3.101.1)

85.4.10 Geological Evidence of Seismicity - Charlevoix (3.102.1)

86.4.2 Neotectonic Conditions in Eastern Canada - Phase I (3.104.1)

86.4.5 Transfer Parameters - Non-Domesticated Animals (3.105.1)

86.4.9 Transfer of Radionuclides to Human Milk - Phase 2 Feasibility (3.106.2)

87.4.1 Stresses to Induce Failure across Faults and Fractures (3.107.1)

87.4.2 A Review of the Validation of Environmental Models (3.108.1)

87.4.3 Measurement of Thorium Concentration in Fish: A Field Study (5.110.2)

87.4.4 Effect of Soil Type on Radionuclides in Plants: Field Study (3.109.2)

87.4.5 Stress Measurements in Eastern Ontario - Phase 4 (3.110.4)

87.4.6 Effective Communication with the General Public (5.111.1)

87.4.7 Transfer of Radionuclides to Human Milk - Phase 3 Field Study (3.106.3)

85.5.8 Verification and Validation for Waste Disposal Models (5.101.1)

85.5.9 Optimization in the Decommissioning of Uranium Tailings (5.102.1)

86.5.1 Waste Management Implications of Concentrating Slimes - II (5.103.2)

86.5.2 State-of-Stress and Groundwater Flow (5.104.1)

86.5.3 Performance of Engineered Barriers for Low-Level Wastes (5.105.1)

86.5.4 Methodology for Estimating Probabilities of Intrusion (5.106.1)

86.5.7 Erosion of Surface and Near-Surface Disposal Facilities (5.107.1)

86.5.8 Plotting for a Groundwater Flow/Contaminant Transport Model (5.108.2)

86.5.9 Sensitivity Study of the Concept of Deep Geologic Disposal (5.109.1)

87.5.1 Remeasurement of Th-230 in the Pore Water of Lacnor Tailings (5.112.1)

87.5.2 Non-Radioactive Contaminants in Uranium Raffinates (5.113.1)

87.5.3 Installation of SYVAC III on AECB Computer (5.114.1)

87.5.4 Software Quality Assurance for Waste Disposal Models (5.115.1)

87.5.5 Development and Administration of UTAP Training Workshop (5.116.1)

87.5.6 Summary of Results from the National Uranium Tailings Program (5.117.1)

87.5.7 Analysis of the Concept of Deep Geologic Disposal (5.109.2)

86.6.2 Doses from Portable Gauges (6.101.1)

86.6.4 Radiation Doses to Technologists from Radiotherapy Treatment Procedures (6.102.1)

87.6.1 Feasibility of Using Beta-Gamma Counting of Ra-228/Ac-228 in Urinalysis (6.103.1)

87.6.2 Production of a Hospital Radiation Safety Officer's Handbook (6.104.1)

86.7.1 Doses to Road Transport Workers from Radioactive Materials (8.101.1)

84.8.10 The Canadian National Dose Registry Study (7.101.1)

84.8.11 Study of the Health Effects of Inhaled Uranium Ore Dust (4.101.1)

84.8.14 Measurement of the Thickness of Bronchial Epithelium (7.102.1)

84.8.15 Measurement of RBE for Tritium for Myeloid Leukemia (7.103.2)

85.8.6 Revision of Name-Encoding Scheme (NYSIIS) for Use by Canadian Epidemiological Studies (7.104.1)

85.8.7 Epidemiological Study of Radiation-Induced Developmental Defects among Canadians (7.105.1)

85.8.8 Comparison of the Techniques Used in Estimating Past Exposures to Radon Daughters in Canadian Mines (4.102.1)

85.8.11 Cost-Effectiveness of Reduction of Off-Site Dose (2.124.1)

85.8.12 Measurement of Absorbed Fraction of Ingested Uranium in Humans (3.103.1)

85.8.13 Full-Scale Study of Health Effects on Central Nervous System following In Utero Exposure (7.106.2)

85.8.15 A Feasibility Study on the Identification and Determination of Exposure Levels of Non-Radiological Carcinogenic Substances at Canadian Nuclear Facilities (7.107.1)

85.8.16 Standardization of Individual Identifying Information for Health Record Keeping Methodology (7.108.1)

85.8.18 Epidemiological Study of Genetic Disorders in Adults (7.109.1)

85.8.20 Screening of Human Populations for Abnormal Radiosensitivity (7.110.1)

85.8.22 In Vitro and In Vivo Studies of the Effects of Ionizing Radiation on the Developing Central Nervous System (7.111.1)

86.8.2 Sensitivity of Bronchial Epithelial Cells to Alpha Radiation (7.113.1)

86.8.4 Study of the Health Effects of Low-Level Exposure to Environmental Radiation in Port Hope (7.114.1)

86.8.6 Study of the Recovery of Kidney Tissue from the Toxic Effects of Uranium (7.115.1)

86.8.8 Cancer Morbidity Follow-Up Feasibility Study Using the National Dose Registry of Canada (7.116.1)

86.8.11 Hospital Record-Keeping System for Case-Control Epidemiological Studies of Radiation-Induced Cancers (7.117.1)

86.8.12 Selection of Control Groups for Use in Epidemiological Studies of Radiation-Induced Health Effects (7.118.1)

86.8.15 Full-Scale Epidemiological Study of Thyroid Cancer from I-131 Exposure (7.119.2)

86.8.18 Ontario Miners Mortality Study - Update (4.106.2)

86.8.19 Cytogenetic Measurements of the Relative Biological Effectiveness of Tritium (7.120.1)

87.8.1 Compilation and Critical Evaluation of Data Used to Derive Current Dosimetric Models for Uranium (3.111.1)

87.8.2 Study of Kidney Functions in Uranium Workers (3.112.1)

87.8.3 Calculation of Derived Release Limits on a Personal Computer (3.113.1)

87.8.4 Measurement of Carbon-14 in Food and in the Excretions of Canadians (2.125.1)

87.8.5 Feasibility Study of Cancer Mortality among Patients Exposed to Ionizing Radiation during Cardiac Catheterization (7.121.1)

87.8.6 Computerized Linkage of National Cancer Incidence Data with Cohorts in Radiation-Related Epidemiological Studies (7.122.1)

87.8.7 Clinical Emergency Response to Accidents Involving Radiation Contamination to Individuals (3.114.1)

87.8.8 Suitability of Neutron Dosimeters and Survey Meters in Various Field Conditions - Phase I (3.115.1)

87.8.9 DNA Repair and Variable Risk in Tumorigenesis (7.123.1)

87.8.10 Superoxide Dismutase in White Blood Cells of Atomic Radiation Workers: An Epidemiological Study (7.124.1)

87.8.11 Pilot Epidemiological Study of Genetic Disorders following Paternal Exposure to Ionizing Radiation and to Other Mutagens at the Work Place (7.125.1)

87.8.12 Promotion and Distribution of the Employee Identification Questionnaire and Its User Guide (7.126.1)

87.8.13 Dose Response of Human Lymphocytes to Radiation and Chemical Carcinogens (7.127.1)

87.8.14 Suitability of Neutron Dosimeters and Survey Meters in Various Field Conditions - Phase II (3.115.2)

87.8.15 Comparison of the Relative Impact of Radiation-Induced Serious Genetic Disorders among Canadians (7.128.1)

87.8.16 Radiation Sensitivity of Organisms Other than Man: A Review (3.116.1)

85.9.2 Socio-Economic Impact Analysis of Proposed General Amendments to Atomic Energy Control Regulations (9.101.1)

86.9.2 Development of a Radiation Safety Training Module for Use in Canadian Uranium and Thorium Mines (4.107.1)

86.9.3 Review of Crisis Management Methods (9.102.1)

87.9.1 Uranium Mine Radiation Safety Course (4.111.1)

87.9.2 Study of the AECB Long Range Plan for Information Management (9.103.1)

87.9.3 Regulatory Effectiveness Measurement System (9.104.1)

STANDARD ABBREVIATIONS AECB ORGANIZATIONAL UNITS		SIGLES COURANTS DES UNITÉS ORGANISATIONNELLES DE LA CCEA
Office of the President	OPR	Bureau du Président
Advisory Committee on Radiation Protection	ACRP	Comité consultatif de la radioprotection
Advisory Committee on Nuclear Safety	ACNS	Comité consultatif de la sûreté nucléaire
Secretariat	SEC	Secrétariat
Secretary to the Board	SEB	Secrétaire de la Commission
Office of Public Information	OPI	Bureau d'information publique
Advisory Committee Secretariat	ACS	Secrétariat des groupes consultatifs
Legal Services Unit	LSU	Services juridiques
Official Languages Adviser	CLO	Conseiller en langues officielles
Medical Liaison Officer	MLO	Agent de liaison médical
Orientation Centre	ORC	Centre d'orientation
Director of Reactor Regulation	DRR	Direction générale, Réglementation des réacteurs
Safety Evaluation Division	SED	Division, Évaluation de la sûreté
Components and Quality Assurance Division	CQAD	Division, Composants et assurance-qualité
Power Reactor Division A	PRDA	Division «A», Réacteurs de puissance
Power Reactor Division B	PRDB	Division «B», Réacteurs de puissance
Operator Certification and Research Facility Division	OCRFD	Division, Accréditation des opérateurs et établissements de recherche
Directorate of Fuel Cycle and Materials Regulation	DFC	Direction générale, Réglementation des matières nucléaires et des radioéléments

Office of Safeguards and Physical Security	OSS	Bureau des garanties et de la sécurité matérielle
Safeguards and Security Division	SSD	Division, Garanties et sécurité
Radioisotopes and Transportation Division	RTD	Division, Radio-isotopes et transports
Compliance Services and Laboratories	CSLD	Division, Contrôles et laboratoires
Uranium Mine Division	UMD	Division, Mines d'uranium
Waste Management Division	WMD	Division, Gestion des déchets
Fuel and Heavy Water Plant Division	FWD	Division, Usines de combustibles et d'eau lourde
Planning and Administration Branch	PAB	Direction, Planification et administration
Planning and Coordination Section	PCS	Section, Planification et coordination
Administration Division	ADD	Division, Administration
Finance Section	FIS	Section, Finances
Personnel Section	PES	Section, Personnel
Information Management Section	IMS	Section, Traitement de l'information
Regulatory Research Branch	RRB	Direction, Études normatives
Radiation Protection Division	RPD	Division, Radioprotection
Health Effects and Regulatory Documents Section	HRS	Section, Effets sur la santé et documents de réglementation
Safety and Safeguards Section	SSS	Section, Sûreté et garanties
Editorial Support Services (OPI)	SAR	Service d'appui à la rédaction
Project Office - Bruce	POB	Bureau de projet - Bruce
- Darlington	POD	- Darlington
- Gentilly	POG	- Gentilly
- Point Lepreau	POL	- Point Lepreau
- Pickering	POP	- Pickering

Laboratory	LAB	Laboratoire
Regional Offices -		Bureaux régionaux -
Central Region	CRO	Région central
Eastern Region	ERO	Région de l'Est
Southern Ontario Region	SORO	Région du Sud de l'Ontario
Western Region	WRO	Région de l'Ouest
Elliot Lake	ELO	Elliot Lake
Accommodation and Material Management	AMM	Gestion des locaux et du matériel
Records Office	REC	Bureau des documents
Library	LIB	Bibliothèque
Administrative Support Group (Floor)	AS4 AS5 AS6 AS7 AS8	Groupe de soutien administratif (Étage)